Quantifying the Social Costs of Cannabis Use to Australia in 2015/16

National Drug Research Institute, Curtin University

June 2020

NDRI national drug research institute
Curtin University
NSW Bureau of Crime Statistics and Research
South Australian Centre for Economic Studies
The University of Adelaide
The University of Queensland Australia
NCETA
UNSW Australia
NDARC National Drug & Alcohol Research Centre

Preventing harmful drug use in Australia

The National Drug Research Institute at Curtin University is supported by funding from the Australian Government under the Drug and Alcohol Program

National Drug Research Institute
Curtin University
GPO Box U1987, Perth, Western Australia, 6845

Telephone: (08) 9266 1600
Facsimile: (08) 9266 1611
Email: ndri@curtin.edu.au
Website: ndri.curtin.edu.au

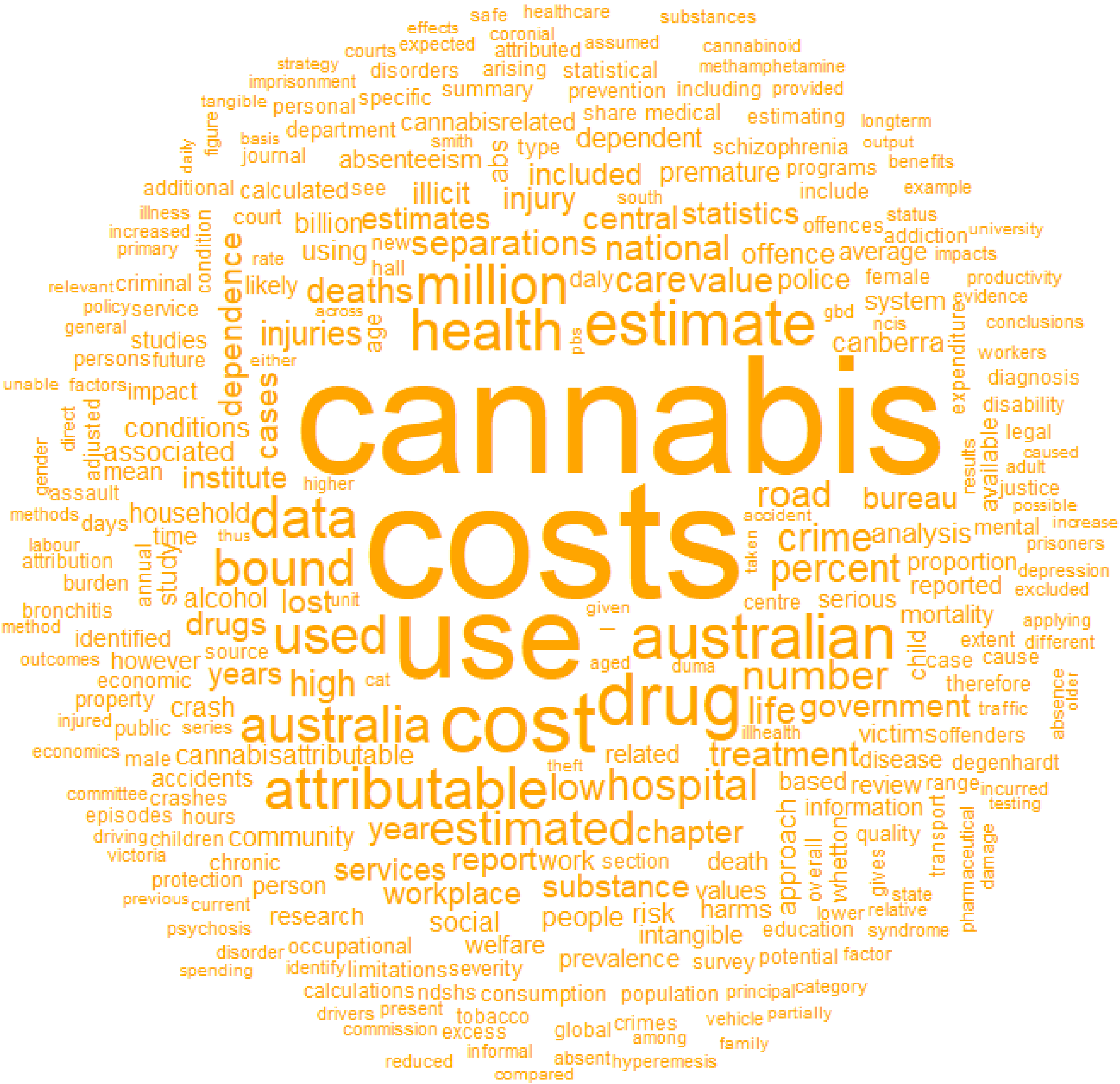
Corresponding Author:
Dr Robert Tait
National Drug Research Institute
Curtin University
GPO Box U1987, Perth, Western Australia, 6845

Telephone: +61 8 9266 1610
Email: robert.tait@curtin.edu.au

CRICOS Provider Code 00301J

ISBN 978-0-6487367-4-5

2020003v2


cannabis
costs
use
cost
drug
australian
australia
attributable
health
estimate
million
data
bound
used
estimated
hospital
deaths
injuries
separations
estimates
national
care
value
number
percent
crime
road
bureau
government
treatment
high
years
drugs
alcohol
lost
dependence
cases
institute
conditions
associated
household
injury
included
illicit
central
statistics
premature
dependent
absenteeism
cannabisrelated
services
workplace
substance
report
chapter
year
low
life
community
cannabisattributable
crash
accidents
social
people
risk
harms
values
intangible
prevalence
welfare
research
occupational
limitations
severity
consumption
population
approach
death
information
disease
victims
offenders
analysis
proportion
reported
mortality
serious
canberra
system
police
offence
average
schizophrenia

QUANTIFYING THE SOCIAL COSTS OF CANNABIS USE TO AUSTRALIA IN 2015/16

Editors
Robert J. Tait [1] & Steve Allsop [1]
National Drug Research Institute
Faculty of Health Sciences
Curtin University
Perth WA

Steve Whetton [2], Robert J. Tait [1], Agata Chrzanowska [3], Neil Donnelly [4], Alice McEntee [5], Aqif Mukhtar [1], Emma Zahra [3], Gabrielle Campbell [3], Louisa Degenhardt [3], Tania Dey [2], Suraya Abdul Halim [2], Wayne Hall [6], Marshall Makate [7], Richard Norman [7], Amy Peacock [3], Ann Roche [5], & Steve Allsop [1]

[1] National Drug Research Institute, Faculty of Health Sciences, Curtin University, Perth, WA
[2] South Australian Centre for Economic Studies, University of Adelaide, Adelaide, SA
[3] National Drug and Alcohol Research Centre, University of New South Wales, Sydney, NSW
[4] NSW Bureau of Crime Statistics and Research, Sydney, NSW
[5] National Centre for Education and Training on Addiction, Flinders University, Adelaide, SA
[6] Centre for Youth Substance Abuse Research, The University of Queensland, Brisbane, QLD
[7] School of Public Health, Faculty of Health Sciences, Curtin University, Perth, WA

Funding
This research was supported by funding from the Australian Government under the:
"*Drug and Alcohol Program*"

Suggested citation: Whetton, S., Tait, R.J., Chrzanowska, A., Donnelly, N., McEntee, A., Mukhtar, A., Zahra, E., Campbell, G., Degenhardt, L., Dey, T., Abdul Halim, S., Hall, W., Makate, M., Norman, R., Peacock, A., Roche, A., Allsop, S. 2020. Quantifying the Social Costs of Cannabis Use to Australia in 2015/16, Tait, R.J., Allsop, S. (Eds.). ISBN 978-0-6487367-4-5, Perth, WA, National Drug Research Institute, Curtin University

External review:
This report was reviewed by Associate Professor Robert Ali, University of Adelaide

EXECUTIVE SUMMARY

Introduction

Globally, in 2018 about 192 million people used cannabis (United Nations Office of Drugs and Crime, 2020). In Australia, about 10 percent of those aged 14 years or older, about 2 million people, reported that they used cannabis in the previous 12 months (Australian Institute of Health and Welfare, 2017i) and over 150,200 are thought to match the criteria for dependence on cannabis (Global Burden of Disease Collaborative Network, 2018). Both in Australia and elsewhere, the legal status of cannabis is in flux, with the increasing availability of prescribed 'medical marijuana' and the decimalisation or legalisation of cannabis use in some countries/states. These alterations will very possibly result in changes in the prevalence of cannabis use and in the groups who consume it. However, there remain potential adverse health and economic consequences of using cannabis.

This report assessed the social and economic costs of cannabis use in Australia during the financial year 2015/16. The report is the fourth in a series assessing the societal costs of using specific drugs (methamphetamine, tobacco, extra-medical opioids and cannabis) to Australia. While each drug has unique costs and impacts, requiring different data to be sourced, the overarching approach remains the same. We focused on the costs in a specific year regardless of when exposure or harms occurred, except for situations where the continuing effects are well-documented, such as in premature mortality where we discounted future costs (lost economic activity and lost contributions to households) and any partially offsetting savings, for example, future health expenditure 'avoided' by premature deaths. Overall, this report most closely replicated that of the analysis of opioid-related costs (Whetton et al., 2020).

Costs were assessed for the following broad domains: premature mortality; inpatient care; out-of-hospital treatments; workplace costs; criminal justice system; road traffic accidents; and, miscellaneous costs such as child protection and prevention programs. Tentative estimates were produced for the lost quality of life for those living with a person dependent on cannabis, the cost of cannabis purchases by those with cannabis dependence and the lost quality of life from cannabis dependence and cannabis-attributed comorbidity. These tentative costs were not added to the overall total.

There were no deaths directly due to cannabis toxicity, but 23 deaths were attributed to cannabis, predominantly from road traffic accidents identified from national data (Australian Bureau of Statistics, 2019b). Cannabis use contributed to nearly 13,000 hospital separations, with the reasons for admission mainly being due to cannabis disorders or cannabis toxicity, but with schizophrenia and related disorders accounting for nearly 30 percent of hospital admissions (Australian Institute of Health and Welfare, 2017b). However, the largest health related costs were for out-of-hospital care that contributed $0.6 billion to the total, in particular for primary care and specialist drug treatment services.

Cannabis use imposes considerable costs in the workplace through its role in occupational injuries and absenteeism ($0.3 billion each). There would also be additional costs from work-related road traffic accidents, which are captured as part of road accidents in general. We also noted that cannabis use is likely to reduce levels of performance at work, for example though intoxication, but we were unable to quantify the extent of this behaviour. Further, early onset of cannabis use and cannabis dependence are associated with lower educational attainment and workforce participation and are thus likely to lower national productivity. We were unable to cost these components.

Given the prevalence of cannabis use and its current legal status, it is unsurprising that the criminal justice system is a major component of the Australian social impacts of cannabis, with a total cost of $2.4 billion. Just under 50 percent of this total was accounted for by imprisonment, which involved over 3,400 prison sentences. There were further costs in administering community supervision orders relating to cannabis offences. Cannabis consumption was also implicated in costs to victims of crime in terms of both personal crime (e.g. assault) and household crime (e.g. burglary). One omission from our report, due to the complexity of programs that vary by jurisdiction, was the separate analysis of diversion programs and specialist drug courts. However, as there are a lack of data about direct contribution of cannabis to specific crimes, it is possible that these estimates under-or over-estimate cannabis' contribution to some categories of crime.

The use of cannabis, especially in the first 3 hours after consumption, has been identified as increasing the likelihood of being an 'at-fault' driver in a road accident. Costs for deaths and hospital separations were included in other sections of the report, so the identified $0.2 billion arises from costs such as long-term disability and damage to property. However, we note that the critical data used in Chapter 8 were collected in 2006 (e.g. crash frequency, severity and costs) (Bureau of Infrastructure Transport and Regional Economics, 2009). While these were consumer price index (CPI) adjusted to reflect 2015/16 costs and the number of accidents adjusted to reflect the increase in cases requiring hospital admission, it is unknown if this applies equally to all categories of road crashes, and hence may under- or over-estimate the involvement of cannabis.

Access to information on child protection cases is, rightly, tightly controlled. We estimated the number of national cases from an analysis of Victorian events and from a small scale South Australian study. Between 7.7 percent and 8.6 percent of child protection cases were estimated to be due to cannabis, which equated to $0.4 billion of the national child protection budget ($4.8 billion). Substantiated child protection cases will involve multiple factors: clearly further research is required to improve the precision of the estimate of the impact of individual components. Given the magnitude of child protection costs, with likely lifelong implications, development and implementation of prevention or early intervention programs are warranted.

Summary Table 1: Summary of costs (with ranges [a]) in 2015/16

Domain	Central estimate ($)	Low bound ($)	High bound ($)
Tangible costs			
Tangible costs of premature mortality (gross) (Chapter 3)	29,548,645	11,068,072	46,042,699
Avoided healthcare costs (Chapter 3)	-627,598	-235,444	-979,807
Hospital inpatient care (Chapter 4)	128,511,008	54,530,555	142,324,790
Other health care (Chapter 5)	585,443,189	291,415,257	914,973,523
Other workplace costs (Chapter 6)	560,208,687	372,338,723	748,078,651
Criminal justice (Chapter 7)	2,399,542,566	1,742,029,110	3,558,210,831
Traffic accidents (Chapter 8)	193,886,949	102,408,456	277,730,883
Miscellaneous costs (Chapter 11)	469,979,798	441,795,093	498,164,503
Total tangible costs	**4,366,493,243**	**3,015,349,822**	**6,184,546,073**
Intangible costs			
Intangible cost of premature mortality (Chapter 3)	106,199,655	10,113,497	490,317,262
TOTAL COSTS	**4,472,692,898**	**3,025,463,319**	**6,674,863,335**

[a] High and low values were not calculated for all domains

There were also cost domains where we developed tentative costings, which were not added into the overall figure. People who live with someone who has cannabis dependence, in particularly partners and children, could experience reduced quality of life. There are about 45,000 children and 27,000 partners who live in a household with a person dependent on cannabis. We quantified this deficit as disability adjusted life years (DALY), which were then converted to a monetary estimate (Summary Table 2). We also used information from the Global Burden of Disease (GBD) study to quantify the lost quality of life that results from cannabis dependence (Degenhardt et al., 2013b; Degenhardt et al., 2013c). For those who are dependent on cannabis, we also estimated the cost of purchasing cannabis. For these people, purchasing decisions may no longer meet the traditional, rational criteria thought to underpin consumption and may have other drivers, such as symptoms of cannabis withdrawal. On this basis, these purchases can legitimately be considered part of the social cost of substance use. Finally, we estimated the cost of disability from comorbidity (e.g. depression, schizophrenia) attributable to cannabis: that is, the DALY beyond those resulting from cannabis dependence. The total of our tentative estimate was $11.0 billion.

Summary Table 2: Summary of costs for tentative estimates and 'internalities' (with ranges) in 2015/16 but not included in the overall total

Domain	Central estimate ($)	Low bound ($)	High bound ($)
Harms to others – partners & children (Chapter 9)	2,537,110,215	398,425,281	7,449,605,395
Value of DALY lost to 'dependence' (Chapter 10) [a]	6,972,893,590	1,095,016,320	20,474,201,479
Cannabis purchases (Chapter 10) [a]	312,432,640	234,324,480	390,540,800
DALY lost to ill-health (Chapter 11) [a]	1,168,755,544	493,207,842	2,340,080,284
TOTAL COSTS	**10,991,191,989**	**2,220,973,923**	**30,654,427,958**

DALY = disability adjusted life years.

[a] These costs relate only to those people classified as dependent on cannabis.

Limitations

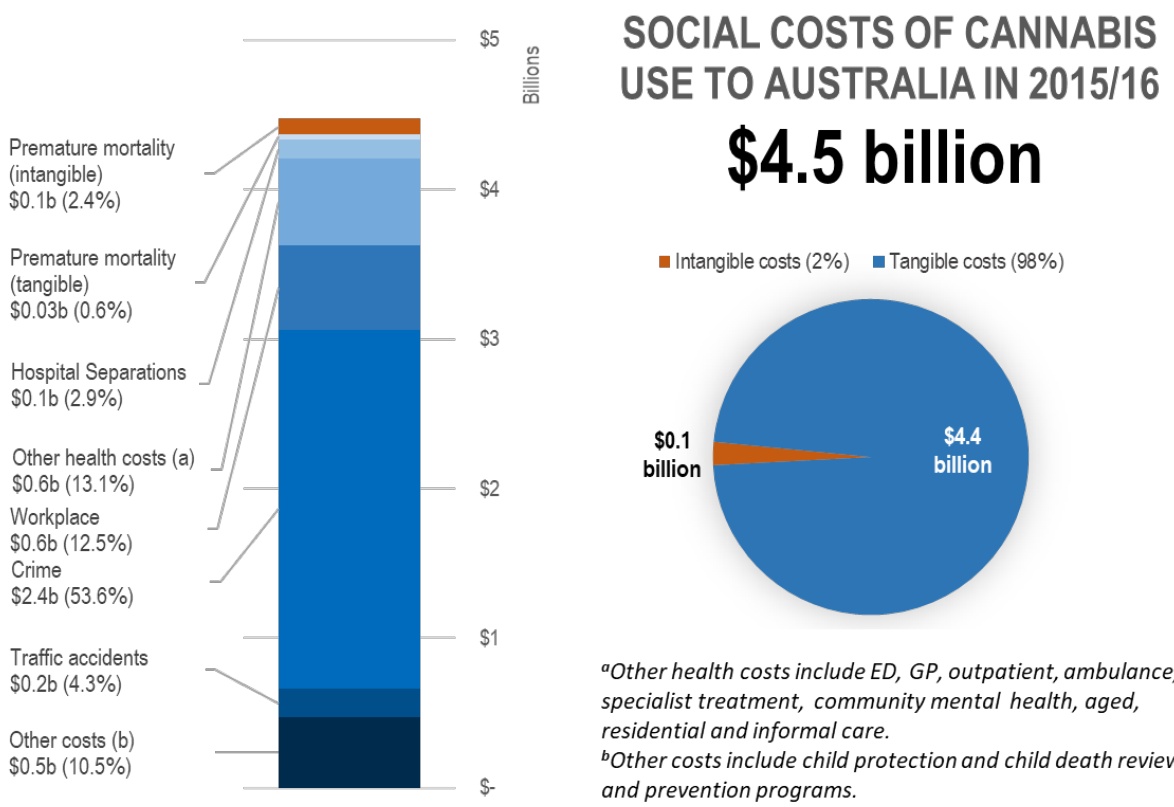
In conducting social cost analyses, there are always challenges in estimating costs from administrative data that are generally not collected with this aim in mind. There are also, at times, far reaching assumptions that are required. For example, in estimating the impact of cannabis use on the criminal justice system we had to extrapolate from the attributions of detainees on the role of drug use in their offending to the calculation of police, court and prison costs. While we believe that this was justifiable, we did not extent this approach into estimating the cost of hospital separations arising from cannabis-related interpersonal violence, an outcome that was included in the criminal justice section. Also, in the criminal justice domain, we were unable to provide any estimate of the costs of either Australian Federal Police activities or of Australian border controls relating to cannabis.

Legislative changes allowing the provision of prescribed 'medical cannabis' came into force late in the target year. There are likely to have been some people consuming cannabis purportedly for medical reasons before and after this change. We did not attempt to quantify any 'health benefits' or reduction in the use of other medications resulting from cannabis consumption (Bradford and Bradford, 2017; Levinsohn and Hill, 2020). Research is required to quantify the benefits of prescribed cannabis, but we note that these results may not translate to the use of different types of cannabis or via alternative modes of delivery, such as smoking or vaping. Finally, we did not attempt to estimate future social costs or benefits under amended cannabis regulatory or legislative models.

Conclusions

About 10 percent of Australian adults report that they have used cannabis in the previous year and over 150,200 are likely to fulfil the criteria for dependence. Despite higher prevalence, the costs due to cannabis at $4.5 billion were far lower than the cost for extra-medial opioid use ($15.8 billion), with about 104,000 people dependent on opioids. The cost difference is mainly accounted for by the comparably few deaths attributed to cannabis and the extensive years of life lost (YLL) due to extra-medical opioid use. The economic costs from cannabis arise mainly through the criminal justice system, including the impact on victims of cannabis-attributed offences.

Summary Figure 1: Distribution of intangible and tangible costs in 2015/16



[a]Other health costs include ED, GP, outpatient, ambulance, specialist treatment, community mental health, aged, residential and informal care.
[b]Other costs include child protection and child death reviews and prevention programs.

Total cost includes savings ($627,598) due to avoided healthcare costs; internalities and intangible costs to cannabis users and their families are not included.

Infographic

WHAT DOES CANNABIS USE COST AUSTRALIA?

2,041,000 Australians USE cannabis
152,000 Australians are DEPENDENT on cannabis
3,422 Cannabis-attributable adult PRISON SENTENCES

The tangible costs of cannabis use amount to $4.4 BILLION

$29 million
Premature death

$714 million
Healthcare costs

$194 million
Road traffic accidents

$2.4 billion
Crime

$560 million
Workplace costs

$470 million
Other costs including child protection

$1.1 billion
Imprisonment

$475 million
Police

$407 million
Personal crime victim

$257 million
Household crime victim

$62 million
Court

$52 million
Legal aid and prosecution

$25 million
Community correction

The intangible cost of cannabis use is $106 MILLION

THE TOTAL COST OF CANNABIS USE IS $4.5 BILLION

Data from 12-month period July 2015 to June 2016

Whetton, S., Tait, R.J., Chrzanowska, A., Donnelly, N., McEntee, A., Mukhtar, A., Zahra, E., Campbell, G., Degenhardt, L., Dey, T., Halim, S.A., Hall, W., Makate, M., Norman, R., Peacock, A., Roche, A. and Allsop,S. (2020). Quantifying the Social Costs of Cannabis Use to Australia in 2015/16. National Drug Research Institute, Curtin University, Perth, Western Australia.

ndri.curtin.edu.au

Table of Contents

Table of tables

Table of figures and text boxes

Abbreviations

ABS	Australian Bureau of Statistics
ACT	Australian Capital Territory
AF	aetiological or attributable fraction
AIC	Australian Institute of Criminology
AIHW	Australian Institute of Health and Welfare
ANZSOC	Australian and New Zealand Standard Offence Classification
AODTS	Alcohol and Other Drug Treatment Services
AR-DRG	Australian Refined Diagnosis Related groups
BEACH	Bettering the Evaluation and Care of Health
BITRE	Bureau of Infrastructure, Transport and Region Economics
CBD	cannabidiol
CHS	Cannabinoid hyperemesis syndrome
CI	confidence intervals
COD	cause of death
COPD	chronic obstructive pulmonary disease
CPI	consumer price index
Δ^9-THC	delta^9-tetrahydrocannabinoid
DALY	disability adjusted life years
DPP	Department of Public Prosecution
DUI	driving under the influence
DUMA	Drug Use Monitoring Australia
ED	emergency department
EUR	European currency unit
GBD	Global Burden of Disease
GDP	gross domestic product
GP	general practice
ICD	International Classification of Disease
ICD-AM-10	International Classification of Disease Australian Modification 10th revision
MSO	most serious offence
NCIS	National Coronial Information System
NDSHS	National Drug Strategy Household Survey
NHMD	National Hospital Morbidity Database
NPV	net present value
NSW	New South Wales
NT	Northern Territory
OR	odds ratio
PBS	Pharmaceutical Benefits Scheme
QALY	quality adjusted life years
QLD	Queensland
Real	value or rate of change after adjusting for the rate of inflation
RPBS	Repatriation Pharmaceutical Benefits Scheme
RR	relative risk
SPI	substance producing injury
TAS	Tasmania
UK	United Kingdom
US or USA	United States of America
USD	United States dollar
US DoT	United States Department of Transportation
VIC	Victoria
VoSL	value of a statistical life
VoSLY	value of a statistical life year
WA	Western Australia
YLD	years of life lost to disability
YLL	years of life lost

CHAPTER 1: INTRODUCTION

Steve Whetton, Robert J. Tait, Agata Chrzanowska, Neil Donnelly, Alice McEntee, Aqif Mukhtar, Emma Zahra, Gabrielle Campbell, Louisa Degenhardt, Tania Dey, Suraya Abdul Halim, Wayne Hall, Marshall Makate, Richard Norman, Amy Peacock, Ann Roche & Steve Allsop

> The approach taken in this report draws extensively from the analyses used in our previous reports on the social cost of methamphetamine (Whetton et al., 2016), the social costs of tobacco (Whetton et al., 2019) and the social costs of extra-medical opioids [1] (Whetton et al., 2020). While the data are unique to cannabis, the rationale and methods demonstrate considerable duplication.

1.1 Rationale

The National Drug Research Institute at Curtin University was engaged by the Australian Government Commonwealth Department of Health to undertake this research into the costs of cannabis to Australia, in collaboration with a multi-disciplinary team of Australian researchers from: the South Australian Centre for Economic Studies, University of Adelaide; the National Drug and Alcohol Research Centre, University of New South Wales; the New South Wales Bureau of Crime Statistics and Research; the National Centre for Education and Training on Addiction, Flinders University; the Centre for Youth Substance Abuse Research, University of Queensland; and, the School of Public Health, Curtin University.

The overarching objective was to produce as comprehensive as possible an estimate of the costs of cannabis use. Costs arising from the side-effects of "medical cannabis" are excluded from these estimates. However, as the relevant legislation was only amended in early 2016 (Australian Government, 2016) and the Therapeutic Goods Administration had given few special access scheme B approvals before 2016 (Therapeutic Goods Administration, 2019) all cases have been assumed to be due to illicit cannabis unless clearly documented otherwise.

The term cannabis is used to cover all synonyms (e.g. marijuana, hashish, ganja) and all routes of consumption (e.g. smoked, eaten, vaporised). The costs associated with "synthetic cannabinoids" were not included in the analysis when they could be separated from those of "plant-based" cannabis. The chemical components of synthetic cannabinoids have rapidly changed over time and may or may not act on cannabinoid receptors and their adverse health outcomes may differ from those produced by the use of plant-based cannabis (Darke et al., 2019; Dresen et al., 2010; Tait et al., 2016).

1.2 Structure of the report

This chapter provides background information on cannabis use, although relevant details are expanded in subsequent chapters. Chapter 2 describes the methods used in the study and the rationale for their selection. The Chapter also provides details on the epidemiology underpinning the cost estimates. In selecting the methods, the starting point was the companion report to this study investigating the costs of extra-medical opioid use (Whetton et al., 2020) and a recent analysis of tobacco social costs (Whetton et al., 2019). Further, we set out the conditions that are wholly or partially caused by cannabis and the attributable fractions (AF) calculated for each of these conditions. In estimating premature mortality, we used two methods. First, direct attribution using data from the National Coronial Information System

[1] The term 'extra-medical opioids' includes illegal opioids and pharmaceutical opioids used not as prescribed.

(NCIS): details of the process used to identify the eligible cases from the NCIS are provided in Chapter 3. Second, we used indirect attribution for conditions where there was strong epidemiological evidence and data from Australian Bureau of Statistics' (ABS) Causes of Death (2019b). To determine the costs of hospital inpatient episodes, we extracted information on cases and cost codes from the Australian Institute of Health and Welfare's (AIHW), National Hospital Morbidity Database (NHMD) as described in Chapter 4. Additional health costs such as: GP appointments; specialist drug treatment agencies; and, emergency department (ED) costs are detailed in Chapter 5.

The use of cannabis also has impacts on workplace absenteeism and injuries: the methods and costs of these workplace episodes are addressed in Chapter 6. Cannabis use has costs across the criminal justice system, including for police, courts and prisons. There are also costs to victims of crime associated with cannabis use. To determine these costs, we accessed data from the Drug Use Monitoring in Australia (DUMA) surveys (Australian Institute of Criminology, 2019) and derived AF for each of the standard categories of offence. These are reported in Chapter 7. The role of cannabis use in road traffic accidents and the estimated costs are addressed in Chapter 8: these accidents also include work-related traffic accidents.

Living with a person who is dependent on cannabis is likely to reduce the quality of life for co-residents, especially partners and children: a tentative estimate of these costs is provided in Chapter 9. In Chapter 10 we evaluated the internalities for people who are dependent on cannabis, including the intangible costs of the lost quality of life arising from associated ill-health and any spending on cannabis by those classified as cannabis dependent. Chapter 11 covers a range of miscellaneous costs, such as the impact of cannabis use on child protection cases and drug prevention programs. In Chapter 12 we provide our overall conclusions and recommendations for future research and highlight the limitations that should be considered in interpreting the overall findings.

1.3 Background

Cannabis is the most widely used illicit drug worldwide, with 192 million people estimated to have used cannabis in 2018 (United Nations Office of Drugs and Crime, 2020), which equates to about 3.8 percent of those aged 15-64 years (United Nations Office of Drugs and Crime, 2019). Despite the high prevalence of cannabis use, its contribution to disability adjusted life years (DALY) lost at 2.0 million, is lower in comparison to opioids, where over 9.1 million DALY are lost with the comparable global prevalence of use being 1.1 percent (Degenhardt et al., 2013c). However, the estimate did not include any deaths (years of life lost (YLL)) in relation to cannabis dependence (Degenhardt et al., 2013c). Also notable was the lower prevalence of cannabis dependence (0.19%) than opioid dependence (0.22%), despite the greater prevalence of cannabis than opioid use (Degenhardt et al., 2013c).

In addition to the illicit use of cannabis, there are some countries and jurisdictions that have either decriminalised or legalised the non-medical use of cannabis: these include Uruguay, Canada and 11 states in the USA plus the District of Columbia (Governing the States and Localities, 2019; Hall, 2018). In addition, increasing numbers of jurisdictions have enacted legislative changes, which have increased access to 'medical marijuana' – that is access to marijuana without civil or criminal penalties based on a clinician's diagnosis and recommendation. Currently, the long-term impact of the changing legal status is unclear (Cerdá et al., 2017). However, there is some evidence that the prevalence of illicit cannabis use and cannabis use disorders have increased in the US states where medical marijuana laws have come into force (Hasin et al., 2017) but this does not appear to have extended to adolescent consumers (Sarvet et al., 2018). Any change in the legal status and potentially prevalence of use of cannabis may therefore have subsequent effects on the costs across a range of domains (e.g. health, criminal justice, workplace). This includes the potential that some costs will increase while others decrease, so caution is required in extrapolating findings between different settings.

Cannabis sativa contains nearly 150 structurally different phytocannabinoid compounds. The most abundant of these being Δ^9-tetrahydrocannabinoid (Δ^9-THC) and cannabidiol (CBD), with the former being responsible for the intoxicating effect of cannabis and the latter possibly offsetting some of the negative side-effects (Chandra et al., 2019; Haney et al., 2016; Hanuš et al., 2016). Therefore, changes in either the concentration of Δ^9-THC or the ratio of Δ^9-THC to CBD have the potential to impact on the health effects of cannabis use. Some reports suggest that there have been such changes. For example, data from the USA and Europe show that between 2008 and 2017, the mean concentration of Δ^9-THC has risen from 8.9 percent to 17.1 percent in analysed samples. Over the same period the ratio of Δ^9-THC to CBD has also increased from 23 to 104 (Chandra et al., 2019). These changes suggest that the risk of adverse effects from the use of cannabis may have increased too, which emphasises the importance of obtaining recent estimates in relation to any putative harms.

In considering the adverse effects of cannabis use, it is important to note the difficulty of adjusting for confounding factors in epidemiological data, in particular the co-use of other licit and illicit drugs together with confounding socioeconomic factors (Volkow et al., 2014). Nevertheless, cannabis use can result in the development of clinical dependence and cannabis use has been implicated in increased risk for some mental health conditions (e.g. depression, schizophrenia), suicide and self-harm, reduced respiratory immune function, and, low birthweight due to maternal use. There is less consistent evidence for potential links to birth defects, lung cancer, and cerebrovascular and cardiovascular complications (Hall and Degenhardt, 2009; Volkow et al., 2014).

1.4 Previous Australian cost estimates

We identified five studies published since 2000 on the costs of cannabis use in Australia (Table 1.1). A national estimate of health care, crime and road accident costs for people who use cannabis reported a total cost of $3.1 billion (Moore, 2007). The report emphasised the difference in annual costs for a person dependent on cannabis ($11,296) compared with others who were not dependent on cannabis ($192). An estimate of hospital costs for cannabis-related treatment found that in 2004/05 the total was about $8.4 million, including separations for withdrawal, dependence and psychotic disorder due to cannabis use (Riddell et al., 2007). Another analysis of hospital costs focused on cannabis withdrawal and dependence syndrome, and estimated a total cost of $5.7 million in 2009/10 (Ritter et al., 2013). Ngui and Shanahan assessed hospital costs in New South Wales (NSW) (Ngui and Shanahan, 2010). In addition to the separations with cannabis diagnostic codes, costs were also calculated for cannabis caused conditions (psychotic disorders / schizophrenia, traffic accidents and low birthweight) plus community treatment. Most of the results for the analysis by Collins and Lapsley (2008) aggregated the costs for illicit drugs. However, an estimated cost for hospital separations due to ‘cannabis abuse’ or dependence was provided ($3.0 million).

Table 1.1: Previous Australian estimates of the social costs of cannabis use

Report	Target year	Conditions included	Total ($)	2015/16 values ($) [1]
Moore (2007)	2004	National hospital costs; other health care; cost of crime; and road accidents	3,115,000,000	4,189,400,000
Riddell et al. (2007)	2004/05	National hospital separations	8,373,516	11,261,651
Collins & Lapsley (2008)	2004/05	National hospital separations	3,054,000	4,062,007
Ngui & Shanahan (2010)	2007	NSW hospital & community costs	16,912,123	20,903,924
Ritter et al. (2013)	2009/10	Hospital costs (withdrawal, dependence)	5,700,000	6,550,000

[1] Adjusted using the ABS consumer price index inflation calculator to December 2015 values (Australian Bureau of Statistics, 2019c).

1.5 Conclusions

We were unable to identify any recent Australian data reporting a comprehensive analysis of social costs of cannabis, with most reports focused on a limited range of diagnostic codes and hospital separations.

CHAPTER 2: METHODS

Steve Whetton, Agata Chrzanowska, Neil Donnelly, Alice McEntee, Aqif Mukhtar, Emma Zahra, Gabrielle Campbell, Louisa Degenhardt, Tania Dey, Suraya Abdul Halim, Wayne Hall, Marshall Makate, Richard Norman, Amy Peacock, Ann Roche, Robert J. Tait & Steve Allsop

2.1 Background

In developing the methods for this study, the objective was to replicate, wherever possible, those used in our recent analysis on the social costs of extra-medical opioid use in Australia for the financial year 2015/16 (Whetton et al., 2020). However, there were some unique costs identified in the current report (e.g. "drug cautions" in the criminal justice system) that were not included in the opioid report. In these cases, the specific methods are noted in the relevant chapters. For those familiar with the methods used in the early report, *the remainder of this chapter on the rationale and methods, duplicates those described in the opioid report* (Whetton et al., 2020), except in providing examples relevant to cannabis use.

Typically, the objective of "social cost studies" is to provide an estimate, in monetary terms, of the overall costs of a condition, disease or behaviour. For illicit substance use, in particular for those with a substance use disorder, these costs are likely to include: medical costs arising from conditions caused (wholly or partly) by the substance; substance use treatment; costs of crime caused by use of the substance (including victims of crime costs); lost workplace productivity and injury; other tangible costs such as road traffic accidents; and, intangible costs (e.g. the intangible costs of premature death and reduced quality of life from ill-health attributable to substance use). Costs especially difficult to quantify are the tangible and intangible costs of substance use on other people, such as resident partners and children. Social costs studies are most frequently used for advocacy in public health and in the identification of high-cost areas.

In conducting social cost studies decisions need to be made regarding:

- What costs are eligible for inclusion in the analysis, in particular whether or not costs to the individual who uses the substance are included with broader social costs?
- The timeframe for the analysis – that is, do the costs in the target period include use during that period and include the cost of previous use or is the analysis focused on use in the target period and future costs?

Having determined the overall scope of the study, it is necessary to:

- Estimate the prevalence of use, by level of potential harm for different types of use, where possible;
- Quantify the types of harm that are either wholly or partially caused by the drug (e.g. via AF calculated from the relative risks (RR));
- Identify sources of cost data for each outcome and the proportion of the total cost that can be attributed to the target substance.

2.2 Approach to economic analysis

2.2.1 Private and social costs

In conducting social cost studies, the typical approach is to exclude any (net) private costs, i.e. costs that accrue to the individual who is purchasing the substance in question. This is on the assumption that in purchasing any particular good or service an individual will only do so where the benefits are expected to be the same or greater than the cost of consumption, including an evaluation of potential non-financial costs such as increased risk of ill-health or other adverse outcomes. Where this is the case there is no economic rationale for public policy intervention.

While this approach is generally accepted for standard products, there is debate about its applicability for substances with 'addictive' potential, especially where costs are incurred by those classified with a substance use dependence. In these cases, consumption decisions may not necessarily be rational and informed. Cawley and Ruhm (2011) provide an excellent review on this topic, which underpins this section.

The 'rational addiction' hypothesis (Becker and Murphy, 1988) has been widely used in modelling the consumption of addictive substances. By definition, it assumes that people make rational evaluations of the current and future costs of their drug use, and it contends that people who use addictive substances consider the risk of dependence when they start using a substance. Therefore, based on this theory any harms arising to that individual should not be a factor in policy decisions and costs to the individual are excluded from social cost analyses.

The validity of the 'rational addiction' hypothesis for those with a drug dependence has been called into question by research findings that undermine its fundamental assumptions, namely that people:

- Typically underestimate the risk of becoming dependent on a drug (Gruber and Köszegi, 2001; Kenkel, 1991);
- Underestimate the potential harms to themselves and have incomplete information on the future adverse effects of using the particular drug (Gruber and Köszegi, 2001; Kenkel, 1991);
- Have inconsistent preferences for the drug in question over time with the likelihood of a present-bias, such as a desire to consume now versus quitting in the future (Angeletos et al., 2001; Gruber and Köszegi, 2001; Laibson, 2001); and,
- Make decisions based on heuristics using incomplete evidence, and do not consider the full future consequences (Akerlof, 1991; Suranovic et al., 1999).

Overall, if the key assumptions of the 'rational addiction' hypothesis are incorrect, then at a minimum, some of the costs of drug dependence can be considered within a social cost framework and can be used to justify public policy interventions that aim to reduce consumption to the point where all costs are factored into consumption decisions (US National Cancer Institute and World Health Organization, 2016). The form that policy interventions take could include actions that decrease availability, increase price, or provide more comprehensive information both to those who already use cannabis and to people who could potentially use cannabis in the future.

Those costs borne by the individual who is dependent on cannabis that are not factored into the consumption decision are termed 'internalities'. Internality Theory allows for time inconsistent decisions by consumers and states that government policy decisions should factor in both internal and external costs. Therefore, changes in taxation levels or other interventions can be justified even when there are no external costs to ensure that individuals who use a substance take all costs into account in their decision making (US National Cancer Institute and World Health Organization, 2016). Thus, social cost studies need to decide if these costs are eligible, and if so, how they should be included.

There are three approaches typically used in addressing 'internalities' in social cost studies:

- Exclude all costs accruing to the individual who uses a substance based either on, a) the belief that the framework provided by the 'rational addiction' hypothesis still confers some utility or, b) the inherent difficulty of quantifying internalities;

- Exclude costs incurred by those who are not dependent but include those costs incurred by those with a drug dependence (i.e. drug-purchases). For instance, where it is reasonable to assume that the person held incomplete information (such as the costs related to premature mortality), include the intangible costs of premature mortality of all people who use a substance, and the cost of drug purchases for those who are dependent (Collins and Lapsley, 2008); and,
- Consider any indirect costs arising from consumption of a substance as a social cost as well as costs directly arising from dependence. The rationale for this approach is that few of the key assumptions underpinning the 'rational addiction' hypothesis are likely to be fulfilled in this situation, with continued consumption amongst individuals who are dependent likely to be mainly driven by the dependence rather than fully informed and rational decisions. Expenditure on the drug incurred by those who are not dependent is still considered as ineligible.

Consistent with the approach used in our previous analyses of the costs of methamphetamine, extra-medical opioids and tobacco use (Whetton et al., 2016; Whetton et al., 2019; Whetton et al., 2020), and the evidence that those who are dependent do not necessarily fully integrate these costs into their decision making, some internal costs were included in our analysis. To the extent possible, we have estimated those internal costs that appear to arise from dependence and excluded those from people who use cannabis that are not dependent, except where costs for those who were dependent and not dependent could not reasonably be separated (such as premature mortality). For example, lost individual income arising from cannabis-attributable imprisonment has been excluded.

2.2.2 Timeframe

The period selected for the study was the financial year 2015/16. This was the most recent year with reasonably comprehensive data. In the current analysis the availably of information on deaths from the NCIS was the critical component in selecting the target year. Coronial findings may be subject to delay, in particular in cases where there are criminal or other proceedings. We selected 2015/16 as the year that provided the best compromise between contemporaneous and comprehensive data. This also coincided with the triannual National Drug Strategy Household Survey (NDSHS) which was conducted in 2016 (Australian Institute of Health and Welfare, 2017h).

2.2.3 Approaches to estimating cost

Consistent with earlier analyses undertaken for the Australian Government, that quantified the social costs of substance use, including licit and illicit drugs, methamphetamine, opioids, alcohol and tobacco (Collins and Lapsley, 1996, 2002, 2008; Whetton et al., 2016; Whetton et al., 2019; Whetton et al., 2020), this study estimated the costs of cannabis for one recent year, namely the financial year 2015/16.

Two broad approaches [2] can be taken to assessing the costs related to a particular study year for a social cost study:

(a) The "incidence approach" involves valuing the marginal impact of drug use in the target year for all subsequent harms of that drug use. The identified future costs are then converted back to their present value equivalent by applying an appropriate discount rate e.g. seven percent. To

[2] Unique to their studies, Collins and Lapsley (1996, 2002, 2008) adopted an alternative method to costing premature mortality which they called the demographic approach. This involved estimating the number of premature substance use attributable deaths that occurred over the 40 years preceding the study year, and then estimating how many of these prematurely deceased individuals would have still been alive in the study year (and how many would have been in the workforce in the study year). This approach was not used for the current study as, in our opinion, the epidemiological data on historical substance use attributable deaths were not of sufficient quality.

calculate future harms in the incidence approach, ‘damage functions’ are required for each attributable form of illness and premature mortality, in order that the increased probability of illness and death for all future years that arose from drug use in the target year can be calculated; or,

(b) The “prevalence approach” involves valuing the costs incurred in the target year from the harms that occurred in that year, whenever the drug use began that produced that harm. The prevalence approach estimates the monetary value of all forms of harm attributable to the drug identified in the target year. In the case of harms which occurred in the target year but incurred costs into the future, such as the lost economic output due to premature mortality, these costs are estimated and then discounted back to their present values by applying an appropriate discount rate.

These two approaches have pros and cons. Where the aim of the study is to assess the future cost of a policy or treatment change, then the incidence approach is preferred. The incidence approach assesses the ‘flow’ of new harms into the future from consumption in the study year. In contrast, the prevalence approach includes some acute harms (‘flow’) and some harms that have arisen from prior exposure (‘stock’ measures). If the aim of the analysis is to evaluate the resources required to address the harms in the target year, then the prevalence approach is preferred. This is especially the case when the stream of future costs is uncertain, if the ‘damage functions’ applicable to the drug are not known for all types of harm, or when there is uncertainty about the lag between exposure and the harm.

In the case of the social cost of cannabis, there are limited epidemiological data to calculate damage functions, and inform assumptions about the lags between exposures and harms, especially cannabis-attributable ill-health for ‘chronic’ conditions. Therefore, we have adopted a prevalence approach focussing on the costs of harm that occurred in the study year. Where possible we have adopted ‘stock’ measures of cost. For example the cannabis-attributable costs of care for those who have been identified with cannabis-related schizophrenia are included for the stock of those receiving care for impairments arising from schizophrenia, regardless of when the schizophrenia was first diagnosed. However, in those cases where harms that occurred in the study year produce long-lived impacts (for example premature deaths, or imprisonment for cannabis-attributable crime) we have included the present value of all future costs of those harms. Overall, we anticipate that the incidence and prevalence approach would produce similar results in the analysis of cannabis costs given the preponderance of acute harms compared with chronic harms. This is in contrast to tobacco-related social costs where harms arising from chronic conditions predominate.

2.2.4 Summary of approach to identification of social costs of cannabis in Australia in 2015/16

The objective of this study was to determine the (net) social costs arising from the (illicit) use of cannabis in any form in the financial year 2015/16. To achieve this: we estimated the number of people whose death was attributable to cannabis (via the NCIS and ABS’ Causes of Death data [3]); the number of hospital separations attributable to cannabis (extracted from the NHMD held by the AIHW), and other health costs. For those causes of death and illness partially caused by cannabis use, the prevalence of daily use (the relevant exposure measure for most conditions of interest) was extracted from the NDSHS (Australian Institute of Health and Welfare, 2017h). We also estimated the long-term future costs of lost productivity and the avoided health care costs associated with cannabis-attributable deaths that occurred in 2015/16, plus the intangible value of those cannabis deaths was estimated. From the DUMA data, we estimated the scale of cannabis-attributable crime, with costs to police, courts and corrections systems identified from administrative data and

[3] See Chapters 3 and 4 methods for details on the identification and attribution of deaths and separations

the costs to victims of crime from estimates produced by the Australian Institute of Criminology. Costs of occupational injury and absenteeism were estimated from Safe Work Australia (2015) data and NDSHS (Australian Institute of Health and Welfare, 2017h).

Our main estimate of those people who were dependent on cannabis came from the Global Burden of Disease Results Tool (Global Burden of Disease Collaborative Network, 2018). We used these data in estimating the intangible costs to people who used cannabis in 2015/16 in terms of suffering disability, pain and other reductions to quality of life due to cannabis-attributable disease. Finally, spending on cannabis by those who are dependent was calculated. For some measures, such as harms to others living with a person with dependence, the number of co-residents had to be derived from the NDSHS data (Australian Institute of Health and Welfare, 2017h). This figure was then adjusted to reflect the age and gender distribution of the Global Burden of Disease (GBD) cohort relative to those identified via the proxy measure of dependence extracted from NDSHS data (e.g. those reporting cannabis use 'daily' [4]).

2.3 Attribution of causality

The use of cannabis is the causal factor for a number of conditions and one of several potential causal factors for other conditions. In estimating the costs of cannabis use, we needed to correctly apportion the premature deaths and morbidity for conditions that are partially caused by cannabis use. Social cost studies have developed three approaches to estimating these costs: indirect attribution; excess attribution; and, direct attribution.

2.3.1 Indirect attribution

Indirect attribution involves using AF calculated from the RR or odds ratios (OR) for the role of cannabis use in the condition and population specific exposure to cannabis. This method is considered to be the most robust as it draws on estimates of RR identified from large populations together with time and location specific exposure data to identify the share of harms attributable to the risk factor in question. In order to calculate the AF, we require the RR from case-control or cohort studies, showing the risk of dying or developing the condition for those who use cannabis compared with those who do not. Further, we need the population prevalence of regular cannabis use by age and gender, typically from self-reported surveys. This was our preferred method for calculating the proportion of hospital separations in this study (see Section 4.3) and partially attributable causes of death (see Section 3.3). In contrast to opioids where toxicity (i.e. overdose) was the major cause of death (COD) (Whetton et al., 2020), there are no conditions where death due to toxicity is directly attributable to cannabis. Thus, all cannabis deaths were identified as either: a significant contributing condition; a direct or antecedent cause; or, via indirect attribution.

English et al. (1995) developed the method used in calculating AF from RR. The formula below is used to determine the AF for a specific condition where the extent of risk varies by the level of consumption of the target substance for a given population (World Health Organization, 2000).

$$AF = \frac{\sum_{i=1}^{n} P_i (RR_i - 1)}{\sum_{i=1}^{n} P_i (RR_i - 1) + 1}$$

Where -

[4] Note: the equivalent proxy measure for 'dependence' used with respect to methamphetamine (Whetton et al., 2016) and extra-medical opioids (Whetton et al., 2020) was 'once a day' or 'weekly'.

i = the consumption levels (in most cases for this study this will be dependent use from the GBD (Global Burden of Disease Collaborative Network, 2018));
P_i = the proportion of the target population who are using at level of consumption i; and,
RR_i = the relative risk of a person at consumption level i of having the condition.

As cannabis is not injected there are no further risks and conditions associated with injecting drug use, unlike extra-medical opioids and methamphetamine. Table 2.1 shows for each condition, by specified International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification code (ICD-10-AM) (Australian Consortium for Classification Development, 2014), the method of attribution used together with the OR or RR used in the analyses and, where relevant, the population prevalence used to measure exposure. The main source in identifying conditions attributable to cannabis was the recent review by Hall and colleagues (2019a; 2019b). Appendix 2.1 shows the AF.

Hall et al. (2019a; 2019b) noted that chronic bronchitis is likely to be partly attributable to regular cannabis smoking, but that no pooled OR or RR were available. Aldington and colleagues (2007) reported an OR of 2.0 (95% confidence interval (CI) 1.4 to 2.7) for people who smoked cannabis compared with people who do not smoke (tobacco or cannabis). Similar values are reported by others. Hancox et al. (2015) reported the odds for the symptoms of bronchitis such as: morning cough (OR 2.0, 95 % CI 1.6- 2.5); sputum production (OR 2.3, 95 % CI 1.8 – 2.9); and, wheeze (OR 1.6, 95 % CI 1.2 – 1.9) for frequent cannabis smokers, adjusting for tobacco consumption. Tashkin and colleagues (2012) found that continued cannabis use was associated with increased episodes of bronchitis (OR 2.3, 95% CI 1.2 – 4.4) compared with never use, controlling for tobacco smoking. Therefore, from this evidence, we propose that an estimate based on an OR of 2.0 is an appropriate order of magnitude.

While there is some evidence for the involvement of cannabis in other conditions, such as suicide ideation and suicide, the lack of well-designed studies prevent their inclusion (Borges et al., 2016).

2.3.2 Excess attribution

The second method of attribution is excess attribution, where estimates are derived from studies that identified 'excess' mortality or morbidity from the condition. In addition, incidence of crime attributable to the substance, provide an AF or proportion of cases attributable to cannabis directly. Due to on-going debate in the literature regarding the extent to which increases in criminal activity can be attributed to cannabis use (Arendt et al., 2013; Norström and Rossow, 2014) the AF for the role of cannabis in interpersonal violence was only used within the crime domain and was not used to estimate hospital separations or premature death attributable to cannabis.

Table 2.1: Cannabis-attributable conditions

Condition/Risk/Injury	ICD-10-AM code	Level of attribution	Approach	Relative risk / odds ratio (95 % CI) Prevalence measure	Source (s)
Mental and behavioural disorders due to use of cannabinoids or cannabis (derivatives) poisoning	F12*, T40.7	Wholly	Direct	AF = 1	ICD-10-AM
Schizophrenia and other psychosis outcomes	F20*-F29*, F30*, F31*	Partially	Indirect	OR = 2·1 (1·5–2·8) Daily use	Marconi et al. (2016)
Depression	F32*, F33*, F34*, F34.1, G41.2	Partially	Indirect	OR = 1.2; 95% CI 1.2-1.3 Daily use	Lev-Ran et al. (2014)
Motor vehicle accidents/ transport injuries [a]	V12-V14 (.3 -.9), V19.4-V19.6, V19.9, V20-V28 (.3 -.9), V29-V79 (.4 -.9), V80.3-V80.5, V81.1, V82.1, V82.9, V83.0-V86 (.0 -.3), V87.0-V87.9, V89.2, V89.3, V89.9 Pedestrian: V02-V04 (.1, .9), V06.1, V09.2, V09.3	Partially	Indirect	RR 1·4 Driving 1 to 3 hours after consumption	Hall et al. (2019a; 2019b)
Cannabinoid hyperemesis syndrome	R11 with (F12.1 or T40.7)	Wholly	Direct	AF = 1	Monte et al. (2019)
Low birthweight (maternal exposure)	P07.0-1	Partially	Indirect	OR = 1.8 95% CI 1.0-3.0 Maternal use during pregnancy	Gunn et al. (2016)
Chronic bronchitis [b]	J41*, J42	Partially	Indirect	OR 2.0 (1.4-2.7) Daily use	Aldington et al. (2007)

* Code starting with.
[a] Attributable fractions for road crash accidents were calculated from the gender specific prevalence of drivers detected with Δ^9-THC, this was then weighted to give an all ages AF using the gender profile of culpable drivers with this weighted AF applied to all road accidents.
[b] We identified a small number (<5) of hospital separations coded as cannabinosis (ICD-10 J66.2): an airway disease caused by specific organic dust – these cases were excluded from the costs.
AF = attributable fraction: ICD-10-AM = International Classification of Disease Australian Modification 10th revision: OR = odds ratio: RR = risk ratio.

2.3.3 Direct attribution

Direct attribution involves the use of expert opinion to attribute additional specific cases. Expert attribution has important limitations, in particular in relation to the criteria used to attribute cases, variation between experts and the extent to which the cases reflect the exposure patterns in the population. However, in the case of rare events, such as illicit drug-related deaths, the level of uncertainly due to random variation between risk and outcomes means that 'correct' apportionment using the indirect approach is problematic. Therefore, in determining the extent to which there were deaths directly attributable to cannabis, we used direct attribution based on the forensic pathologists' reports in coronial files (see Sections 3.2.1 and 3.2.2 for details). Direct attribution is also implicitly used in those hospital separations which are attributable wholly to cannabis. By definition, hospital diagnostic codes are reliant on the information recorded in case files and on the coding undertaken in the hospital as to the cause being one that is wholly attributable to cannabis.

2.4 Epidemiological basis for cost calculations

2.4.1 Which people who use substances are included?

The attributable harms arising from cannabis use are likely to vary with the type, quantity and frequency with which the drug is used, the context of use, level of drug dependence and, method of use (e.g. eaten *versus* inhaled). In some instances, the prevalence of interest may be "any use" over the past year which approximates to all people who currently use cannabis. In other cases, in estimating the extent of harm, the focus of interest is on those who are dependent on cannabis.

Our main estimate for people who were dependent on cannabis came from the GBD Results Tool (Global Burden of Disease Collaborative Network, 2018). As the tool provides data by calendar year, we used the mean values for 2015 and 2016 (Table 2.2) in estimating the intangible costs to people who used cannabis in 2015/16 in terms of suffering disability, pain and other reductions to quality of life due to cannabis-attributable disease. Estimated spending on cannabis by those who were dependent was also calculated. For some measures, such as harms to others, where the household structure of people who were dependent on cannabis were required, a proxy measure of the number of people who had a family member dependent on cannabis had to be derived from the NDSHS data. This estimate used data on the household structure of those using cannabis most frequently ('daily') to approximate the household structure of those in the same age group and gender who were dependent on cannabis (See Table 2.3) (Australian Institute of Health and Welfare, 2017h).

As noted above, our preferred source for dependent use was the GBD compare tool. The GBD systematically reviews the literature on each topic (e.g. cannabis dependence) to identify reports on the prevalence, incidence, remission and excess mortality, which must include a measure of clinical "caseness" (e.g. based on ICD criteria). Prevalence by age, sex, year and country is estimated using DisMod-MR modelling. The GBD study acknowledges the potential for under-reporting of stigmatised behaviours, such as illicit drug use, in data collected through direct survey methods. Therefore, preference is given to indirect methods including back-projection and capture-recapture and these estimates are used to adjust ("crosswalk") prevalence estimated derived from surveys (Vos et al., 2017). However, the GBD study does not provide an estimate of the prevalence of cannabis use that does not fulfil clinical criteria.

Table 2.2: Cannabis dependence prevalence (number and percent) age 15 years and older

Cohort	Central estimate	Low bound	High bound
Male mean 2015/16	99,610.2 (0.969)	77,967.1 (0.759)	125,148.1 (1.218)
Female mean 2015/16	50,598.1 (0.481)	38,526.0 (0.366)	64,654.0 (0.615)
Total mean 2015/16	150,208.4 (0.721)	117,736.3 (0.565)	188,239.9 (0.904)

Source Global Burden of Disease (Global Burden of Disease Collaborative Network, 2018)

A second source of data was the NDSHS (Australian Institute of Health and Welfare, 2017h). The NDSHS is a triennial national survey of the use of licit (i.e. alcohol, tobacco) and illicit drugs (cannabis, methamphetamine, cocaine, heroin etc.). The survey collects demographic information, measures wellbeing, and gathers opinions on alcohol and other drug issues. The NDSHS uses a complex multi-stage probabilistic sampling framework in order to collect data on a representative sample of people. The response rate for the 2016 survey was 51.1 percent. In 2016, the NDSHS surveyed 23,772 individuals aged 12 years and over in Australia. Many questions, however, were not asked of 12 and 13 year olds (Australian Institute of Health and Welfare, 2017h). In 2016, 10.0 percent of Australians aged 14 years or older had used cannabis in the past 12 months (Australian Institute of Health and Welfare, 2017i). Notably, there has been a decline in the reported recent use of cannabis: in 2001 the prevalence was 12.9 percent, while since 2007 it has been in the range 9.1 to 10.4 percent (Australian Institute of Health and Welfare, 2017e)

Table 2.3: Estimated 2015/16 prevalence of cannabis use aged 14 or 15 years or older by frequency of use over the past year

Source	Cannabis use category	Age	N (%)
NDSHS	Daily	14 or older	292,906 (1.4)
	Once a week or more		450,017 (2.2)
	Once a month + every few months		600,728 (2.9)
	Once or twice a year		697,377 (3.4)
	Any recent use – total		2,041,028 (10.0)
GBD	Dependent use (estimated on clinical criteria)	15 or older	150,208 (0.72)

Sources: National Drug Strategy Household Survey (Australian Institute of Health and Welfare, 2017i) and Global Burden of Disease (Global Burden of Disease Collaborative Network, 2018).
GBD = Global Burden of Disease: NDSHS = National Drug Strategy Household Survey

Despite the declining survey response rate, the estimated prevalence of alcohol and tobacco use, and commonly used illicit drugs, such as cannabis, is generally regarded as reliable from the NDSHS. The accuracy of data for other illicit drugs, and the extent to which it accurately captures the behaviours of those with a drug use disorder and those who inject, is likely to be less reliable (Hickman et al., 2002). *Household* surveys will miss the most disadvantaged people who use drugs, such as those who are homeless, living in hostels, institutions or in unstable accommodation. Further, heavy or problematic substance use is not uniformly distributed geographically, and thus may not be adequately sampled in national household surveys (McKetin et al., 2005). Finally, at least in the case of methamphetamine, media attention appears to have increased stigmatisation of methamphetamine use, resulting in under-reporting in the NDSHS in comparison to cocaine and ecstasy use (Chalmers et al., 2016). Unfortunately, the study did not assess the situation with respect to cannabis, so the potential for under-reporting of cannabis use is unknown.

2.4.2 Poly-substance use

Poly-substance use is common among people who use drugs of all types. For example, among those seeking treatment for cannabis use, 52 percent also listed an additional drug of concern (alcohol 33%, nicotine 25%, amphetamine 22%, ecstasy 4%, benzodiazepines 3%, heroin 2%,) (Australian Institute of Health and Welfare, 2017d). Further, nearly 80 percent of people reported having used alcohol at the same time as cannabis and 60 percent have used tobacco at the same time (Australian Institute of Health and Welfare, 2017e). This has implications for all aspects of the current analysis in attributing costs (e.g. health care, crime). Therefore, except for instances where the AF is one, such as cannabis dependence, the attribution of harms to a particular substance carries a measure of uncertainty and, in some cases, uses relatively crude estimates of the attributable costs.

2.4.3 Generalising from a sample

As noted above (Section 2.4.1), even nationally representative datasets may not provide reliable data on the extent of cannabis use, especially for those with more severe substance use problems or in specific groups or locations not well represented in the data. However, national data are not available for all cannabis-related harms (e.g. Section 11.1.3 Child protection costs). Therefore, we have had to rely on state–based or even single-study estimates of some harms. In these cases, this has been acknowledged in the limitations section of the respective Chapters.

2.4.4 Range of costs

As a result of these uncertainties, in addition to our best estimate of costs, where possible we also estimated a lower and upper range, using plausible alternative values or sources of data. Where data are available, we present our best estimate of costs together with a high and low range. Where a range was not calculated we used the central estimate to replace the missing boundary(s) (e.g. Summary Table 5.6). Alternatively, where we were only able to estimate the outer boundaries, their mean was used as the central estimate (e.g. expenditure on cannabis Chapter 10).

2.5 Included and excluded costs

The issue of excluded costs, in particular where data were missing, is detailed in Chapter 12. Nevertheless, we are aware of areas where costs were incurred but we were unable to quantify them – for example, the Australian Federal Police and border control operations. In addition, it seems likely that those living in remote and regional areas will have different costs to those in metropolitan areas: we were unable to quantify the extent of this difference.

Our analysis has not attempted to estimate the “opportunity-costs” in this area. An illustration of a potential-opportunity cost is that expenditure on the treatment of cannabis-related conditions could have been used in other areas of government expenditure.

CHAPTER 3: PREMATURE MORTALITY

Emma Zahra, Steve Whetton, Gabrielle Campbell, Louisa Degenhardt, Wayne Hall & Robert J. Tait

3.1 Illicit cannabis-attributable mortality

An analysis conducted for the GBD study attributed no deaths to the use of cannabis (Degenhardt et al., 2018). Similarly, a review of cannabis-attributable harms (Hall et al., 2019b) noted that cannabis use could not produce an equivalent to an opioid 'overdose', although there was some evidence that its use could account for a small number of premature deaths from cardiovascular disease, stroke or cannabis hyperemesis syndrome (Jouanjus et al., 2014; Nourbakhsh et al., 2019). Cannabis intoxication increases the risk of motor vehicle accidents, including fatal accidents (Rogeberg and Elvik, 2016). In Section 2.3.1 the evidence for the role of cannabis use in chronic bronchitis was explored, and we decided to include this as a condition partly attributed to cannabis, and as a cause of premature mortality.

3.2 Identification of cannabis-attributable deaths

This report draws upon the rationale and methods used in the previous analysis of the social cost of extra-medical opioids (Whetton et al., 2020). The two approaches used to estimate substance attributable deaths were the direct and indirect method. The direct method examines coronial records for deaths in which the forensic pathologist cited the substance as a medical COD. The indirect method calculates AF from strong epidemiological evidence, which are then applied to the gross number of deaths that were caused from the risk or injury.

This study used the direct approach to examine all cannabis-related deaths identified in the NCIS database. The indirect method was used to calculate cannabis-related road crash injuries and chronic bronchitis, as there are potentially multiple causal factors for both. This approach attributes a proportion of those deaths to cannabis use based on RR identified in literature and prevalence of use by age and gender (Chapter 2).

Other conditions associated with plant-based cannabis use that may have implications for premature mortality such as cannabinoid hyperemesis syndrome, cardiovascular disease and stroke, were unable to be estimated as components to calculate AF or gross number of deaths were not available.

3.2.1 National Coronial Information System

The NCIS was established to form a centralised database of Australian and New Zealand coronial records. Australian States and Territories begun contributing records from the 1st of July 2000, except for Queensland (1st of January 2001). Jurisdictional requirements for reporting a death to the coroner are in accordance with the corresponding Coroners Act and these requirements do vary. A general definition of reportable deaths are those that are unexpected, unexplained, unnatural, occurred whilst in care or custody, health care related or if the identity of the deceased is unknown (National Coronial Information System, 2019b). The percentage of deaths reported to the coroner of all Australian deaths in 2015 and 2016 was 12.4 percent, as reported on the 9th January 2019 (Table 3.1).

A case is created for each death that is reported to the coroner. A complete case comprises of four documents, a police narrative, the coroner's findings, toxicology report and an autopsy report. The length of the coronial process varies depending on the complexity of the case, meaning cases with criminal proceedings or that require extensive investigation may be significantly delayed. Once procedures are completed by the coroner the case is closed and then becomes available for authorised researchers to examine. The delay between the date of death and case closure can extend from months to years. The share of closed cases (of all cases reported to the coroner) for 2015 and 2016 at the time this study was conducted were 91.1 and 87.0 percent respectively (National Coronial Information System, 2019a).

Table 3.1: Total number of deaths in Australia, 2015 & 2016 as per Australian Bureau of Statistics (ABS), compared to number of National Coronial Information System (NCIS) cases

Category	2015	2016
Total ABS deaths in Australia [1]	159,052	158,504
Total NCIS notified cases in Australia [2]	19,774	19,678
NCIS Closed cases in Australia [2], n (%)	18,011 (91.1)	17,112 (87.0)

Reproduced with permission from Whetton et al. (2020). [1] ABS (2019b): [2] Numbers reported at time of case extraction, 9th January 2019 NCIS (2019a).
Calculations by the authors.

Approvals from the Ethics Committees of the University of New South Wales and the Department of Justice and Community Safety were obtained (NCIS M0063/CCOV RC265).

3.2.2 Search strategy in NCIS

All closed cases of cannabis-related deaths that occurred in Australia between the 1st July 2015 and 30th June 2016 were examined between February and June 2019. Substance related deaths with a positive detection of cannabis, or its metabolite [5], in the toxicology report were extracted using the search by 'Object or Substance Producing Injury' function. The NCIS drug search categories extracted were 'Marijuana, Cannabis', 'Other Cannabinoids and Related Drugs' and 'Synthetic Cannabinoids'. Text searches of the medical COD statements retrieved cases containing 'canna' and 'marij'.

3.2.3 Case selection

Each case was reviewed to determine if cannabis was cited in the COD statement by the forensic pathologist. Cases were separated into two categories:

1) Medical COD: if cannabis was cited in the COD statement; or
2) Substance Producing Injury (SPI): if cannabis was **not** cited in the COD statement but was coded by NCIS as a positive detection in the toxicology report, or the combination of substances was unspecified in the cause of death. Examples of such terms are 'multidrug toxicity, or 'mixed drug effect'.

As the attribution of cannabis in the SPI cases is not definitively stated by the forensic pathologist the current study examined medical COD cases only.

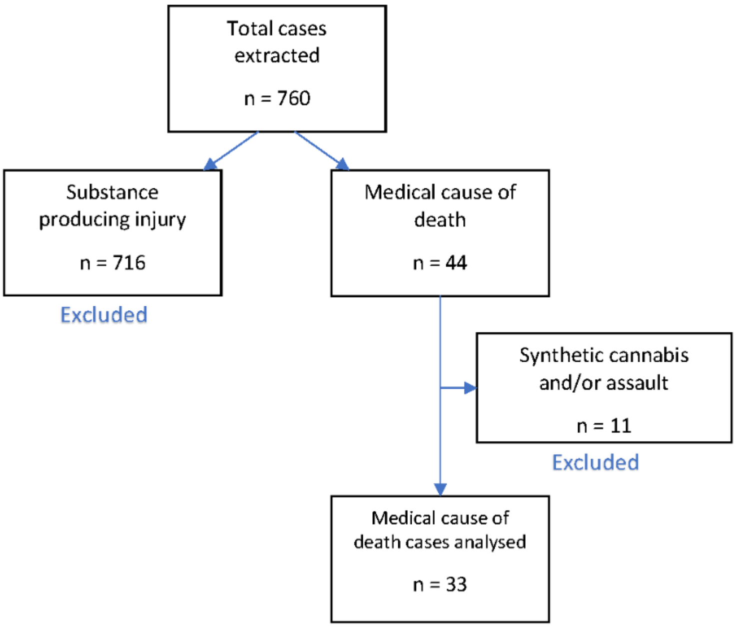
Case characteristics and circumstances were examined including, demographics, intent (as determined by the coroner), role of cannabis in the COD statement (i.e. direct or antecedent cause, or other significant conditions contributing to the death but not relating to the disease or condition causing it), category of cause (drug toxicity, disease with/without drug toxicity, accidental injury/trauma, or suicide) and concomitant substances. The categorical groupings were selected in order to conceal small case numbers as per the data usage agreement.

[5] As the attribution of cannabis in the SPI cases is not definitively stated by the forensic pathologist the current study examined COD cases only.

3.2.4 Results of NCIS analysis

A total of 760 cases were identified. The forensic pathologist listed cannabis as a medical cause of death in 44 cases. Cases classified as 'assault' or if only a 'synthetic cannabinoid' was listed were excluded from further analysis (n=11). Assault cases were excluded as information about how cannabis contributed to the death, in particular the perpetrators actions, is limited. Synthetic cannabinoid cases were excluded as the substance is different to plant-derived cannabis and therefore has different associated mortality risks (Darke et al., 2019). The remaining cases were categorised as SPI (n=716) and as mentioned, were excluded from further investigations.

Figure 3.1: Flowchart of case selection



Analysis of the 33 medical COD cases revealed a mean age of 35.0 years and three quarters of cases were male (Table 3.2). Cannabis was recorded as a significant contributing condition in 54.5 percent of cases (n = 18) and a direct or antecedent cause of death in 45.5 percent (n = 15). A third of cases were intentional self-harm of varying mechanisms (including drug overdose, hanging/asphyxiation and fall from height). Cases were predominately unintentional (45.5%), a third were intentional (33.3%) and over a fifth were undetermined, unlikely to be known or due to natural cause(s) (21.2%). Multiple drug toxicity accounted for just under a quarter of deaths (24.2%). A fifth of deaths were due to disease with or without drug toxicity (21.2%). Similarly, a fifth of deaths were from accidental injuries, such as transport related accidents, drownings and falls.

Notably, cases predominately had multiple substances listed in the cause of death (84.8%). The substances most frequently cited alongside cannabis were, alcohol (36.4%), psychostimulants (33.3%), opioids (30.3%) and benzodiazepines (27.3%). The circumstances of death for the cases where cannabis was the sole drug identified (n = 5) were accidental trauma, suicide and natural cause/s of death (disease).

Table 3.2: Cannabis-related deaths [a] in Australia identified via coronial (NCIS) data [b] (financial year 2015/2016): n = 33

Characteristic			Data	
Age mean (SD)			35.0	(13.6)
Age groups in years % (n)				
	≤18 under		-	(<5)
	19 – 54		84.8	28
	≥55		-	(<5)
Gender % (n)				
	Male		75.8	(25)
	Female		24.2	(8)
Intent % (n)				
	Unintentional		45.5	(15)
	Intentional		33.3	(11)
	Undetermined/Unlikely to be known/[b] Due to natural cause(s)		21.2	(7)
Role of Cannabis in Death % (n)				
	Direct or antecedent cause		45.5	(15)
	Significant contributing condition		54.5	(18)
Category of Cause % (n)				
	Drug toxicity			
		Cannabis only	0	(0)
		Multiple Substances	24.2	(8)
	Disease with/without drug toxicity		21.2	(7)
	Accidental Injury/Trauma		21.2	(7)
	Suicide		33.3	(11)

SD = Standard deviation.
[a] Cannabis only (n = 5), multiple substances (n = 28).
[b] The NCIS classification of deaths due to natural cause/s includes deaths from disease processes (National Coronial Information System, 2018).
Case numbers <5 are concealed to maintain confidentiality as per data use agreement.

Consistent with published literature, no deaths were found to be wholly attributable to plant-derived cannabis toxicity (Hall et al., 2019b). As no deaths were identified as cannabis-induced (deaths occurring from isolated cannabis use) the findings from NCIS data have not been used to estimate the social cost of cannabis pre-mature mortality. Alternatively, indirect methods were used to estimate cannabis-related deaths.

3.3 Identification of cannabis-attributable deaths from other sources

Causes of death in which cannabis is partially contributory were estimated using the indirect approach using the RR detailed in Chapter 2. Conditions identified as partially caused by cannabis with epidemiological data available were:

- Chronic bronchitis;
- Low birthweight; and,
- Road crash injuries.

There is evidence that cannabis consumption whilst pregnant is linked to an increased risk of low birthweight infants, however there are no reliable data on the prevalence of cannabis use whilst pregnant in Australia, and therefore it was not possible to identify what proportion of deaths arising from low weight at birth were attributable to maternal cannabis use (Gunn et al., 2016).

In addition, there is evidence that cannabis use may be linked to higher rates of involvement in criminal activity, although there is considerable debate about the scale and nature of the link (Arendt et al., 2013; Norström and Rossow, 2014). The evidence is not regarded as sufficiently robust to include an estimate of deaths from interpersonal violence that could potentially be attributable to cannabis use, and so no estimates for this cause of death are included.

3.3.1 Chronic bronchitis

The gross number of deaths categorised as due to chronic bronchitis (underlying cause of death ICD-10 codes J41 and J42) in Australia for the years 2015 and 2016 were sourced from ABS' Causes of Death data (Australian Bureau of Statistics, 2019b).[6] The average of the total deaths in 2015 and 2016 equalled 23. Unfortunately, the ABS deaths file does not report data by age bands for lower frequency conditions. For the purposes of calculating the AF and costs it has been assumed that the age profile of deaths from chronic bronchitis matched those of hospital separations.

The AF for cannabis as a cause of chronic bronchitis ranges from 0.026 for males aged 15 to 49 to <0.001 for females aged 70+ (Appendix 2.1). Applying these AF to the estimated age structure of deaths due to chronic bronchitis gives an estimate of 0.14 cannabis-attributable deaths (low bound 0.06 deaths, high bound 0.25 deaths).

3.3.2 Road crash injuries

Acute cannabis intoxication increases this risk of accidental road crash incidents due to cannabis's short term impacts on the cognitive and psychomotor skills necessary for driving, with a range of consequences including fatal injuries (Ch'ng et al., 2007; Drummer et al., 2003; Verstraete and Legrand, 2014).

We used the estimated RR of road crash injuries where a person drove 1-3 hours subsequent to cannabis use calculated by Hall and colleagues (RR = 1.37) (Hall et al., 2019a; Hall et al., 2019b). The active component of cannabis (Δ^9-THC) is metabolised to produce an active metabolite 11-hydroxy-THC with subsequent oxidation to 11-nor-9-carboxy-THC. In chronic, frequent cannabis consumers, Δ^9-THC can be detected in blood up to 30 days post consumption, with the active metabolite detectable to 3 days and 11-nor-9-carboxy-THC at more than 33 days (Bergamaschi et al., 2013). Thus, there are practical difficulties in assessing driver impairment in real world settings.

Estimates of the prevalence of driving whilst intoxicated by cannabis are quite variable, reflecting differences in the way the data are calculated. Studies which rely on positive drug detections from police roadside drug tests often report relatively high prevalence of use (e.g. Chu and colleagues (2012) report detection of Δ^9-THC in 42 percent of tested Victorian drivers; and Wundersitz and Konstad (2017) report detection rates of 17.8 percent in South Australia in 2016). However, these police activities do not represent a random sample, rather police typically target testing resources at locations and times of the day when they are more likely to detect drivers under the influence of alcohol and/or illicit drugs. For this study we have used the reported prevalence of drivers testing positive to cannabis in a random series of tests conducted in Queensland, which found 1.3 percent of drivers tested positive to Δ^9-THC (Davey and Freeman, 2009). However, detection of cannabis does not in itself indicate the extent of impairment.

[6] This is likely to slightly understate the number of deaths as there are a similar number of cases where it could not be identified whether the bronchitis was acute or chronic.

As the risk arises from the cannabis consumption of the at-fault driver, gender specific AF were calculated based on the estimated prevalence of consuming cannabis prior to driving, and this was then weighted by the probability of persons of that gender being the at-fault driver in a road crash (Drummer et al., 2003). The estimated weighted AF is 0.014 (low bound 0.005, high bound 0.025). A total of **23 deaths** are estimated to be caused by cannabis-attributable road accident injuries.

Table 3.3: Cannabis-attributable deaths due to road crash injuries

Cause of injury	Female			Male			Persons		
	central estimate	low bound	high bound	central estimate	low bound	high bound	central estimate	low bound	high bound
Pedestrian road injuries	1.4	0.5	2.2	3.0	1.1	4.7	4.4	1.7	6.9
Cyclist road injuries	0.1	0.0	0.1	0.6	0.2	1.0	0.7	0.3	1.1
Motorcyclist road injuries	0.2	0.1	0.4	2.9	1.1	4.5	3.1	1.2	4.8
Motor vehicle road injuries	5.1	1.9	7.9	9.5	3.6	14.8	14.6	5.5	22.7
Other road injuries	0.1	0.0	0.1	0.1	0.0	0.1	0.2	0.1	0.2
Total road accident injury deaths	6.8	2.6	10.6	16.1	6.0	25.1	23.0	8.6	35.7

NB: Totals may not sum due to rounding

3.4 Total cannabis indirectly attributable deaths

We estimate that there were 23 premature deaths attributable to cannabis (range 9 to 36) (Table 3.4), almost all of which were from road accident injuries. Seventy percent of the cannabis-attributable deaths are amongst males. The total years of life lost (YLL) to cannabis-attributable deaths was 856 years (range 321 to 1,334 years).

Table 3.4: Total estimated cannabis indirectly attributable deaths

Cause	Female			Male			Persons		
	central estimate	low bound	high bound	central estimate	low bound	high bound	central estimate	low bound	high bound
'Cannabis deaths' (NCIS data)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chronic bronchitis	0.1	0.0	0.2	0.1	0.0	0.1	0.1	0.1	0.3
Road accident injury	6.8	2.6	10.6	16.1	6.0	25.1	23.0	8.6	35.7
Total cannabis-attributable deaths	6.9	2.6	10.8	16.2	6.1	25.2	23.1	8.7	36.0
Total years of life lost to cannabis-attributable death	247.1	92.5	385.2	609.1	228.2	948.8	856.2	320.7	1,334.0

N/A: NCIS deaths calculated by direct attribution: no cases of cannabis-induced deaths identified.
NB: Totals may not sum due to rounding.

3.5 Tangible costs of premature mortality

Two broad forms of social cost arise as a result of premature mortality: tangible and intangible costs. Tangible costs are those costs for which a market price exists as they can effectively be traded in the market economy. Intangible costs are those costs that cannot be traded, such as reduced quality of life from ill-health or the value placed on the lost years of being alive.

The YLL for each premature death were calculated using age and gender specific estimates for years of life remaining from the ABS life tables (Australian Bureau of Statistics, 2018a). YLL were calculated in both undiscounted and discounted forms, with the latter used in the cost calculations. Age and gender specific probabilities of employment were used to calculate the expected number of working years lost in the study year and the present value over the analysis period. Discounting was undertaken using a real discount rate of 7 percent as recommended in Australian Government guidance (Department of Finance and Administration, 2006; Department of the Prime Minister and Cabinet, 2016).

Tangible costs of premature mortality include: the present value of lost expected lifetime labour in paid employment (excluding where possible the present value of any private income that would have flowed to a non-dependent person who used cannabis); costs to employers of workplace disruption; the lifetime value of lost labour in the household; and, a net cost saving from the present value of avoided lifetime medical expenditure by the government. Productivity impacts are calculated per year for some period into the future and so require the number of deaths in the reference year to be converted into a YLL estimate, whereas intangible costs are calculated directly from the number of deaths that occurred in the reference year.

No costs have been included in the analysis for funerals and associated expenses, as it has been assumed that the cost of these remain constant in real terms and so there is no net cost (or net saving) from them having occurred prematurely.

3.5.1 Workplace costs of premature mortality

The impacts of a premature death on workplace productivity, where the decedent is in paid employment, are the present value of expected future economic output from the deceased individual [7], together with the cost to employers of filling a job vacancy.

The impact of a smaller labour force on gross domestic product (GDP) due to cannabis-attributable deaths in 2015/16 was calculated as a present value over a 30-year timeframe (to align with the Department of Finance and Administration guidance (2006)) using a real discount rate of 7 percent. It is assumed that the costs of filling job vacancies occurred in 2015/16, the year in which the premature death occurred.

The age- and gender-specific probability that an individual will be in employment in each of the following 30 years was taken from analysis of 2016 Census of Population and Housing data (Australian Bureau of Statistics, 2017c, Data extraction by the authors). Deaths data for the conditions included in this analysis were available in age groups rather than single years of age. Age group specific employment rates were calculated by averaging across the age band, with the analysis being otherwise the same.

Over the analysis period, an estimated discounted 166 years of working life were lost due to cannabis-attributable premature death (95% CI: 62 - 259).

Data are not available on the way in which the economic output attributable to labour varies across the workforce, or how the economic impact of those who died prematurely from cannabis-attributable causes

---

[7] In theory, to the extent that the deceased person was not an individual who was dependent on cannabis, that proportion of expected lifetime economic output that would have flowed to them as wages should be excluded, as a private rather than social cost. However, almost all of the deaths attributed to cannabis in this analysis were road accidents and it is not possible to identify the proportion of the decedents who were the person using cannabis as opposed to other persons involved in the accident. Therefore, all of the workplace costs of premature mortality were included.

differs from the average. It was assumed that the economic output of those in work equalled the population mean. GDP per employee was calculated from current price estimates of GDP for the year July 2015 to June 2016 from the ABS national accounts and average employment over 2015/16 (Australian Bureau of Statistics, 2019a, d) and was $139,697 [8].

The total present value cost to GDP of premature cannabis-attributable mortality which occurred in 2015/16 assessed over 30 years was **$23.2 million** in 2015/16 values (low bound $8.7 million, high bound $36.1 million) (Table 3.5).

In addition, employers face one-off costs to recruit new employees to replace deceased workers, and to train those new workers. The estimated cost of this was $6,422 per prematurely deceased employee in 2006 values (Bureau of Infrastructure Transport and Regional Economics, 2009). Converting to 2015/16 values using the change in the CPI (Australian Bureau of Statistics, 2019c) and applying the estimate of 11 persons who died from cannabis-attributable causes in 2015/16 and were in employment at the time of their death, gives a total cost of **$89,492** (Table 3.5).

3.5.2 Reductions in labour in the household

Collins and Lapsley based their estimates of the value of lost labour in the household on the ABS publication Unpaid Work and the Australian Economy 1997 (Australian Bureau of Statistics, 1997; Collins and Lapsley, 2008). The latter remains the best available source of data on unpaid work in the household despite now being dated. Under the definitions used in the report, a household activity is considered unpaid work if an economic agent other than the household itself could have supplied an equivalent service. Such services include domestic activities, childcare, purchasing of goods and services, and volunteer and community work. These are all services that are lost by the community in the event of the death or severe illness of the person supplying them, and are therefore counted as a component of social costs (Collins and Lapsley, 2008).

The ABS (1997) report details two broad approaches that can be taken to valuing unpaid household labour: individual function replacement cost (which can be valued either by the cost of outsourcing each of the specific tasks, or by the cost of hiring a full time housekeeper to provide all of the services lost); and, the opportunity-cost of time (typically measured by the market value of the deceased person's time in work). In this analysis we have used individual function replacement costs, as using opportunity-cost applies a zero value to work undertaken by individuals not in the labour force and therefore tends to systematically understate the value of work undertaken by women who have lower employment rates. This was also the approach taken by Collins and Lapsley (2008).

The total value of male unpaid labour in the household was estimated at $82 billion in 2007 values and female unpaid labour was valued at $154 billion. Converting these figures to per adult estimates using the population data used in the ABS estimates of the value of unpaid household labour (Australian Bureau of Statistics, 1997) and to 2015/16 values using the CPI (Australian Bureau of Statistics, 2019c) gives values of unpaid household work of $19,613 per adult male and $35,016 per adult female. We assumed that the value of unpaid labour in the household for those aged less than 18 and those aged over 75 years old was zero, as individuals aged less than 18 are often dependent (at least partially) on service

[8] This GDP per worker is slightly different than that used in the recently released report into the social cost of tobacco (Whetton et al., 2019) as the ABS has made minor revisions to their estimates of current prices, GDP and employment for 2015/16 since the tobacco analysis was completed.

provision from adults in the household, and above the age of 75 a substantial proportion of the population are either in receipt of formal or informal care, or are providing informal care to another member of their household, which is captured as part of 'other medical costs' (see Chapter 5), creating the risk of double counting.

At the same time as the total discounted YLL were estimated, we also estimated the number of YLL within the age ranges used for the household labour calculation to generate age- and gender- (or age group- and gender-) specific years of household labour lost.

Our central estimate was that there were 265 discounted years of household labour lost to cannabis-attributable death over the study period (low bound 118, high bound 344). This gives an estimated present value of **$6.3 million** ($2.3 million to $9.8 million).

3.6 Avoided health care costs

Cannabis-attributable diseases cause healthcare costs (see Chapters 4 and 5), however the premature deaths caused by cannabis use also produces partially offsetting reductions in lifetime healthcare costs which these individuals would have incurred in future years had they lived to their expected age at death.

As with the costs of lost economic output, age and gender (or age group and gender) specific discounted YLL for each premature death were calculated.

Annual average recurrent healthcare costs per person by five-year age groups for 2015/16 (all ages average: $6,671) were taken from Health Expenditure Australia data (Australian Institute of Health and Welfare, 2017f) and it was assumed that healthcare costs would grow in line with per capita GDP (e.g. YLL were discounted at 7% to allow for an estimated annual real increase in costs of 1.5% per annum).

The estimated total net present value (NPV) (over 30 years using a 7% real discount rate) of healthcare costs avoided due to premature cannabis-attributable mortality was a **saving of $0.6 million** (low bound $0.2 million, high bound $1.0 million) (Table 3.5).

3.7 Intangible costs

Much of the cost to society arising from premature mortality relates to intangible costs, e.g. those costs which relate to factors that cannot be traded or transferred. Valuation of the intangible costs of premature mortality is usually undertaken using what is known as the Value of a Statistical Life (VoSL).

It is important to note that the concept being assessed is ***not*** the value of one or more of the individual lives lost prematurely due to the health condition or hazard in question. Rather the concept is based on society's average willingness to pay to reduce the risk of premature death by one case. Estimates of this value are generally derived from an individual's direct market behaviour, such as willingness to pay for products that result in a small reduction of risk, e.g. additional safety features on cars, or the increase in wage demanded to take a job that has a higher risk of premature mortality.

Current guidance for cost benefit analyses undertaken for the Australian Government recommends using a VoSL that was developed by Abelson (2008). Abelson recommended using a VoSL of $3 to $4 million in 2006/07 values. Abelson's recommended value was not derived from a meta-analysis of valuation studies, which produce much higher estimates. Rather, whilst it took note of a range of published meta-analyses of both wage premium studies, product market, and willingness-to-pay approaches to valuing a statistical life, it was most strongly influenced by the values recommended by the United Kingdom (UK) government and the European Union member countries.

The Abelson estimate was in 2007 values and, for this analysis, needed to be converted to 2015/16 values. The rate at which a VoSL should increase over time as national incomes increase is determined by the income elasticity of demand for reductions in the risk of premature death, with the elasticity representing the proportionate increase in the VoSL for a given increase in per capita incomes. For example, an income elasticity of 0.5 implies that for a 1% increase in per capita income, the VoSL would increase by 0.5%. These income elasticities have been variously estimated at 0.5 to 0.6 (Viscusi and Aldy, 2003), 1.32 (with a range from 1.16 to 2.06) (Kniesner et al., 2010) and 1.5 to 1.6 (Costa and Kahn, 2004). We followed the US Department of Transportation (US DoT) (2015) in adopting a relatively conservative assumption of an income elasticity of 1.0 [9], slightly below the average of the three studies which was 1.16.

Therefore, the central estimate was converted from 2007 values to 2015/16 values using the change in the average nominal national per capita income over that period, giving a 2015/16 VoSL of $4.6 million.

Internationally, much higher values are often used reflecting the findings of studies into the VoSL [10]. The US DoT used a VoSL of US$9.1 million in 2013 values (2015). This was derived by averaging 15 hedonic wage studies (e.g. studies which estimated the wage premium demand by workers for more dangerous occupations and using the difference in annual mortality rates between industries to calculate the implicit value placed on a premature death). The US Environment Protection Authority also adopted a similar approach, using a similar but slightly different value derived from a slightly different set of studies. Converting the US DoT VoSL estimate to Australian dollars using Purchasing Power Parity exchange rates (Organisation for Economic Cooperation and Development, 2016), and then to 2015/16 values using the growth in per capita current prices GDP (Australian Bureau of Statistics, 2018c) from 2012/13 to 2015/16 gives a VoSL of $13.6 million. This value is used as our high bound estimate.

There is debate in the literature as to whether studies should use a consistent value of averting a premature death, regardless of the expected age of person whose death is averted, or whether it would be more appropriate to use a consistent value for each expected YLL with the value of averting a premature death then varying substantially by age.

In general, using a consistent value for an averted death tends to be used in studies of reductions in transport, health and environmental risks (see for example, (Abelson, 2008; HM Treasury (UK), 2018; US Department of Transportation, 2015)). Values based on life years tend to be used in drug or medical device funding approvals (see for example National Institute of Clinical Excellence 2004 for the UK (2004) and the processes adopted for adding pharmaceuticals to the Pharmaceutical Benefits Scheme (PBS) subsidies Australia (Community Affairs References Committee, 2015)).

Adopting a value of a life year approach has the effect of giving greater weight to premature deaths amongst the young and much lower weight to deaths amongst the old. For example, using the value of a

[9] This is likely to be an underestimate, as empirical analysis suggests that on average people are risk averse (and in particular loss averse) which would imply a price elasticity of averting loss of >1 (Kniesner et al., 2010).

[10] Viscusi and Aldy undertook a meta-analysis of studies that used wage differentials and of those which looked at price premia paid for increased safety features in goods purchased and found the mean of the studies was US$6.7 million in 2000 prices (Viscusi and Aldy, 2003).

statistical life year (VoSLY) derived from Abelson (2008) updated to 2015/16 values (method described below) would imply that society would be willing to spend $5.15 million to avert the premature death of a 1 year-old female and $5.13 million to avert the premature death of a 1 year-old male, but the willingness to spend to avert the premature death of an 80 year-old would be $2.20 million for a female and $1.95 million for a male. On the other hand, adopting a single value for a VoSL implies higher values per year of life gained for older persons and lower values per year of life gained for younger persons.

This study has adopted a VoSL approach for its central estimate, reflecting the preponderance of usage in policy studies, as well as the pattern of health spending over the life which tends to reflect need and therefore grow with age from the middle years of life (Australian Bureau of Statistics, 2017b), rather than see a drop-off in the last years of life when the care could be expected to produce relatively few additional years of healthy life, and the willingness to spend on safety improvements only appears to fall modestly with age once adjusted for ability to pay and then only after the age of 70 (Pearce, 2000).

However, as a lower bound for our estimate of the intangible cost of cannabis-attributable mortality we have estimated the cost using a VoSLY approach.

VoSLY are derived from the VoSL by treating the Value of a Statistical Life as the equivalent to the present value of an annuity over the expected years of life remaining, using the following formula:

$$VoSLY_{t=1} = VoSL \times \frac{(1-(1+g)/(1+r))}{(1-(\frac{1+g}{1+r})^{years})}$$

Where:
VoSL = the value of a statistical life being used, in this case from Abelson, 2008 converted to 2015/16 values;
g = the annual escalation factor used for the VoSL, in this case the expected long-term per capita growth rate in GDP of 1.5 percent per annum;
r = the discount rate used, in this case seven percent real per annum; and,
years = the number of years of healthy life remaining assumed to be implicit in the VoSL calculation, in this case following Abelson 2008 we have used 40 years.

This VoSLY is applied to the estimated potential YLL calculated from the mortality data. Unlike the tangible cost estimates, costs are included for each expected year of life remaining even where that occurs more than thirty years in the future. These annual costs are then converted to a present value estimate using a real discount rate of 7 percent.

In order to ensure consistency with other estimates, we used the Abelson values for our main estimates, which gives an expected intangible cost of cannabis-attributable premature mortality in 2015/16 of **$106.2 million** (Table 3.5)**.**

If, instead, the VoSL estimate used by the US DoT (2015) were to be used, then the estimated intangible cost of cannabis-attributable premature mortality in 2015/16 would be $490.3 million, taken as the high bound estimate.

Finally, if intangible costs of premature mortality were valued based on potential YLL, then the intangible cost of cannabis-attributable premature mortality in 2015/16 would have an expected present value of $10.1 million, being the low bound estimate.

3.8 Total costs of premature mortality

Drawing together the estimated tangible and intangible costs of premature cannabis-attributable mortality, our central estimate of the cost is **$135.1 million** ($20.9 million to $535.4 million). Tangible costs are $28.9 million, with intangible cost accounting for $106.2 million (Table 3.5).

Table 3.5: Costs of cannabis-attributable premature mortality (all values in 2015/16 terms)

Cost	Central estimate	Low bound	High bound
	Tangible costs		
NPV of lost economic output: non-employee	23,191,166	8,686,658	36,134,446
Recruitment/training costs to employers	89,492	33,524	139,466
NPV of value of lost unpaid household work	6,267,987	2,347,890	9,768,787
Gross tangible costs	29,548,645	11,068,072	46,042,699
NPV of healthcare costs avoided	-627,598	-235,444	-979,807
Total net tangible costs	**28,921,047**	**10,832,628**	**45,062,892**
	Intangible costs		
VoSL	106,199,655 [a]	10,113,497 [b]	490,317,262 [c]
TOTAL COSTS	**135,120,701**	**20,946,125**	**535,380,154**

[a] = Central estimate of cannabis attributable deaths, costed using Abelson (2008) value of a statistical life;
[b] = low bound estimate of years of life lost to cannabis attributable death, costed using the value of a statistical life year derived from Abelson (2008) converted to 2015/16 values; and,
c = high bound estimate of cannabis attributable deaths, costed using the value of a statistical life from the US Department of Transport (2015) guidance converted to Australian dollars and then to 2015/16 values.
NPV = net present value: VoSL = value of a statistical life.

3.9 Conclusions

Our results show the limited extent of a link between cannabis use and premature mortality, with an estimated 23 deaths attributed to cannabis. As a consequence of this low impact on mortality, costs are also relatively low. Data from the NCIS indicated 33 cases where cannabis use was identified, but there were no cases of cannabis-induced deaths. Therefore, our estimate was based solely on the indirect method.

3.10 Limitations

The main caveats of this study relate to features of the NCIS and the availability of strong epidemiological evidence for cannabis-related conditions and injuries.

The limitations of the NCIS include jurisdictional differences, case closure timeframes, coding errors and the disparity in documentation methods (noting that substance terms used by forensic pathologists in the COD statement are not standardised) (Bugeja et al., 2016). At the time of this study the percentage of Australian closed cases (of all cases reported to the coroner) for 2015 and 2016, were 91.1 and 87.0 percent respectively (National Coronial Information System, 2019a). NCIS data do not allow for the analysis of premature mortality due to all drug-related conditions. If a treating medical officer determines that the death was due to natural disease and the circumstances are not considered to be reportable to the coroner, it will not be included in the NCIS.

Other diseases associated with cannabis use that have implications for premature mortality, such as cardiovascular disease, stroke, and cannabinoid hyperemesis syndrome, were unable to be estimated as components to calculate AF or gross number of deaths were not available.

Acknowledgments

The authors acknowledge NCIS as a database source and the Department of Justice and Community Safety as the source organisation of that data. We thank the NCIS staff for their assistance. The authors acknowledge and thank the Ethics Committees of the Department of Justice and Regulation for and on behalf of the State of Victoria, and the University of New South Wales, University Human Research Ethics Committee.

CHAPTER 4: HOSPITAL INPATIENT MORBIDITY

Agata Chrzanowska, Steve Whetton, Wayne Hall, Amy Peacock, Louisa Degenhardt & Robert J. Tait

4.1 Background

Cannabis use can be responsible for a number of serious health events which can lead to hospitalisation. These conditions can include acute intoxication and poisoning, as well as other health problems due to long-term heavy usage (Jouanjus et al., 2011).

In Australia, the total number of hospital separations where cannabis use was identified as being directly responsible for a patient's admission to the hospital (i.e., the principal diagnosis) has more than doubled in the last ten years (from 2,994 in 2007-08 to 6,205 in 2017-18) (Chrzanowska et al., 2019), with a similar increase in the age-standardised rate (Figure 4.1). We speculate that given the decline in the prevalence of recent cannabis use since 2001 (Australian Institute of Health and Welfare, 2017e), this increase may be due to the changes in the potency or composition of cannabis (Chandra et al., 2019; Swift et al., 2013), or from more frequent use among those who consume cannabis or from the use of synthetic cannabinoids, where the first documented Australian death was in 2011 (Darke et al., 2019). However, there may be other explanations for these trends, noting that increases in hospitalisations over this time period were observed for other drugs (cocaine, amphetamines, opioids) (Chrzanowska et al., 2019).

Figure 4.1: Age-standardised rates (per 100,000 people) of cannabis-related hospital separations in Australia, 1999-2000 to 2017-2018

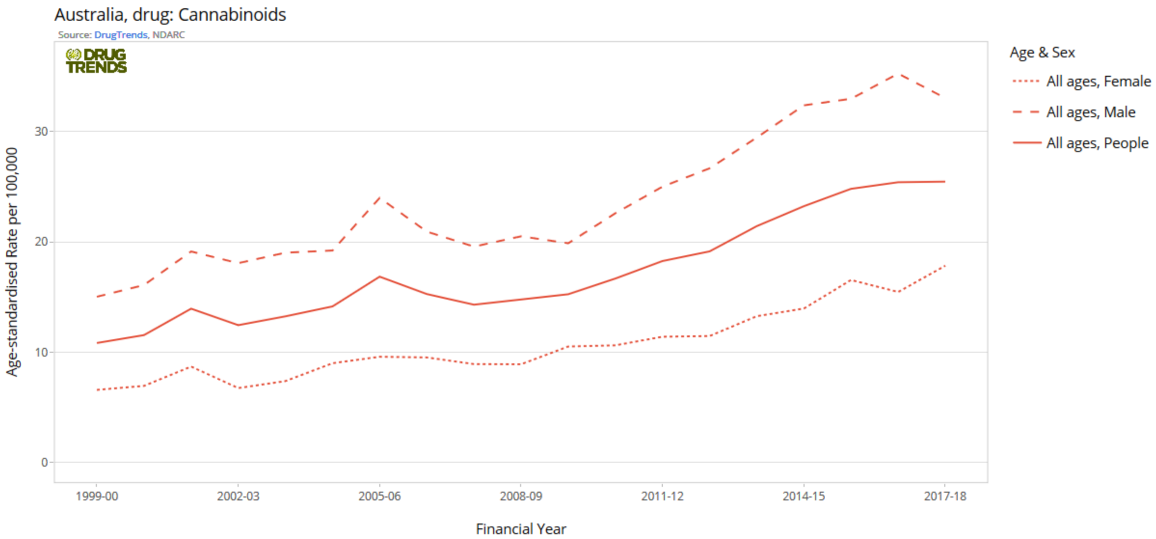


Figure reproduced from Chrzanowska et al. (2019).

We gathered available medical and scientific information on the risk of cannabis in causing specific conditions and used them to estimate the cost of inpatient hospitalisations related to the use of cannabis. The current ICD-10-AM does not allow one to distinguish hospitalisations related to plant-based cannabis use from those related to synthetic cannabinoids. Therefore, in this chapter we used the term "cannabis-related hospital separations" to describe all hospitalisations related to either plant-based cannabis or synthetic cannabinoids: elsewhere in the report, costs due to synthetic cannabinoid use are excluded where they can be identified.

The current study used a variety of methods described in Chapter 2:

1. **Direct attribution** for conditions wholly attributable to cannabis use and dependence, based on cannabis diagnoses in the inpatient hospital separation data where the below conditions were coded at separation:
   - Principal diagnosis was mental and behavioural disorder due to use of cannabinoids, or cannabis (derivatives) poisoning; and,
   - Cannabinoid hyperemesis syndrome (CHS) coded as nausea and vomiting in the principal diagnosis underlying the hospitalisation, and mental and behavioural disorder due to use of cannabinoids, or cannabis (derivatives) poisoning was identified in any of the additional diagnoses.

2. **Indirect attribution** for conditions wholly or partially attributable to cannabis use and dependence, where the AF was calculated based on the available RR or OR and the exposed proportion of the population (or its best available estimate), and applied to the total number of hospital separations with a principal diagnosis indicating the specific condition or external diagnosis reflecting a particular injury (excluding any separation directly attributable to cannabis and already counted for another condition using the direct approach):
   - Chronic bronchitis;
   - Schizophrenia and other psychosis outcomes;
   - Depression; or,
   - Road crash injuries.

There is good evidence that cannabis consumption whilst pregnant is linked to an increased risk of low birthweight infants and high quality RR estimates are available, however, there are no reliable Australian data on the prevalence of cannabis use whilst pregnant and possible confounding by tobacco use and other factors (Conner et al., 2016; Gunn et al., 2016). Therefore, the relevant AF could not be calculated, and this condition was not included in the current analysis.

3. **Excess attribution** is used for conditions partially attributable to cannabis use, where a RR was not available, but where evidence of a causal effect was present. There were no conditions where the excess attribution approach was used to calculate AF for this study.

All hospital separations already counted using the direct approach in analysis of the opioid-related hospital inpatient morbidity for the report 'Quantifying the Social Costs of Pharmaceutical Opioid Misuse & Illicit Opioid Use to Australia in 2015/16' (Whetton et al., 2020) were excluded from analysis for this chapter.

4.1.1 Data source

We used data extracted from the National Hospital Morbidity Database (NHMD) for the 2015/16 financial year held by the AIHW (Australian Institute of Health and Welfare, 2017b). These data are a collection of all de-identified patient-level separation records from public and private hospitals in Australia. For jurisdictions other than Tasmania, we had access to all diagnoses for all hospitalisations. The Tasmanian data were limited to: records that included a drug and alcohol related principal and/or additional diagnoses and external causes; and, only the drug and alcohol related diagnosis codes were provided for those records.

In the NHMD extract for 2015/16, diagnostic and external cause were coded upon separation from ICD-10-AM (Australian Consortium for Classification Development, 2014). In the current analysis the critical ICD-10-AM codes used to identify the conditions of interest are listed in Table 4.1.

It should be noted that in this report we adopted the standard terms relating to hospital separations employed by the AIHW (Box 4.1) (Australian Institute of Health and Welfare, 2017b).

Box 4.1: Summary of terms relating to hospital separations

An **admitted patient** is a patient who undergoes a formal admission process to receive treatment and/or care in hospital.

A **hospital separation** (also called hospitalisation) refers to a completed episode of an admitted patient's care in a hospital ending with a discharge, death, transfer or a portion of a hospital stay beginning or ending in a change to another type of care. There can be more than one hospital separation for each patient and separations can be either same-day (hospital admission and separation happen on the same day) or overnight (hospital admission and separation happen on a different date). Each NHMD separation record includes one principal diagnosis and up to 99 additional diagnoses.

The **principal diagnosis** is defined as the diagnosis established after study to be chiefly responsible for occasioning the patient's episode of admitted patient care. **Additional diagnoses** are conditions or complaints that either coexists with the principal diagnosis or develop during the episode of care and affect patient's management. In this report, we use **any diagnosis** to refer to the principal and/or additional diagnosis.

The environmental events, circumstances or conditions that caused injury, poisoning and other adverse effects are recorded in NHMD as **external causes**. Each NHMD separation record includes up to 100 external causes.

A **cannabis-related code** refers to an ICD-10-AM code which indicates a diagnosis directly related to cannabis poisoning, or mental and behavioural disorder due to use of cannabinoids, i.e. F12.0-F12.9, T40.7 (see Table 4.1).

The reimbursement of hospital costs is based on the classification of separations using the Australian Refined Diagnosis Related Group (AR-DRG) (Independent Hospital Pricing Authority, 2015). Using the AR-DRG, specific cost categories are assigned to each separation record based on the patient's diagnoses, primary type of treatment or service provided, the difficulty of the case, and the severity of any complications. The data we received were coded using AR-DRG version 7.0. These AR-DRG codes are accompanied by a costweight which indicates the average cost of administering that treatment with respect to the average cost of an acuity adjusted hospital separation. In 2015/16 an average acuity condition (e.g. costweight = 1.0) cost $5,194 on average per hospital separation (Independent Hospital Pricing Authority, 2018). From this we estimated the cost of specific separations by multiplying their costweight by the average cost of a separation (see below):

Total Cost = $5,194 x average cost weight of condition x number of attributed separations

We excluded records where patient sex was not stated and the DRG code was 960Z (Ungroupable with missing costweight).

Table 4.1: Relationship between conditions and ICD-10-AM codes

Condition	ICD-10-AM Diagnosis/external causes	Source
Directly attributable cannabis-related conditions		
Mental and behavioural disorders due to use of cannabinoids	PD: F12*	Australian Consortium for Classification Development (2014)
Poisoning by cannabis (derivatives)	PD: T40.7	
Cannabinoid hyperemesis syndrome	PD: R11 + AD: F12.1, PD: R11 + AD: T40.7	Massachusetts Health Information Management Association(2017)
Indirectly attributable cannabis-related conditions [1]		
Chronic bronchitis	PD: J41*, J42	Australian Consortium for Classification Development (2014), Victoria State Government (2017)
Schizophrenia and other psychosis outcomes	PD: F20*-F29*, F30*, F31*	Di Forti et al. (2014)
Depression	PD: F32*, F33*, F34.1, F41.2	Fiest et al. (2014), Doktorchik et al. (2019)
Road crash injuries	EC: V12-V14 (.3 -.9), V19.4-V19.6, V19.9, V20-V28 (.3 -.9), V29-V79 (.4 -.9), V80.3-V80.5, V81.1, V82.1, V82.9, V83-V86 (.0 -.3), V87.0-V87.9, V89.2, V89.3, V89.9 V02-V04 (.1, .9), V06.1, V09.2, V09.3	Chihuri & Li (2019)

*All ICD-10-AM codes that start with this letter-digit combination.
[1] Low birthweight excluded as we were unable to find data on the prevalence of cannabis use when pregnant.
AD = additional diagnosis: EC = external cause: PD = principal diagnosis.

4.2 Hospital separations directly attributable to cannabis use

4.2.1 Principal diagnosis – cannabinoid use disorder or cannabis poisoning

All hospital separations with a principal diagnosis indicating a mental or behavioural disorder due to use of cannabinoids or poisoning by cannabis were considered wholly attributed to cannabis, regardless of other drugs being reported in additional diagnoses [11], and the total cost of these separations was counted for the purpose of this report. Hospital separations solely attributable to cannabis were identified by the following ICD-10-AM codes appearing as the principal diagnosis:

- F12.0-F12.9 - Mental and behavioural disorders due to use of cannabinoids; and,
- T40.7 - Poisoning by cannabis (derivatives).

There were 5,833 separations with a cannabis-related ICD-10-AM code as the principal diagnosis in 2015/16: 5,476 hospitalisations due to mental and behavioural disorders related to use of cannabinoids, and 357 hospitalisations due to cannabis poisoning. These are further classified into AR-DRGs such as drug intoxication and withdrawal, drug use disorder and dependence, poisoning and toxic effect of drugs. Two of the separations were excluded from further analysis due to missing sex or ungrouped (960Z) AR-DRG code with missing costweight. For the full list of cannabis-related principal diagnosis by the assigned AR-DRGs with cost weights, frequencies and hospitalisation costs see Table 4.2. Total costs for hospital

[11] Unless already counted in the companion opioid report (Whetton et al., 2020)

separations for cannabis-related principal diagnoses were **$33.2 million** ($23.0 million for males and $10.2 million for females).

Table 4.2: Number of hospital separations and costs associated with cannabis-related principal diagnosis, 2015/16

AR-DRG code	AR-DRG description	Total number of hospital separations[1] Male	Female	Cost-weight
A06A	Tracheostomy W Ventilation >=96hrs W Cat CC	<5	0	32.5886
A06B	Ventilation >=96hrs and OR Proc (W/O Tracheostomy or W/O Cat CC)	<5	0	15.9717
B63Z	Dementia and Other Chronic Disturbances of Cerebral Function	<5	0	3.7605
B64B	Delirium W/O Cat CC	<5	<5	1.4881
V61Z	Drug Intoxication and Withdrawal	1,576	676	1.9168
V64Z	Other Drug Use and Dependence	929	478	1.1108
V66Z	Treatment for Drug Disorders, Same day	1,151	659	0.1094
X06B	Other Procedures for Other Injuries W/O Cat or Sev CC	<5	0	0.9046
X40Z	Injuries, Poisoning and Toxic Effects of Drugs W Ventilator Support	5	0	2.1126
X62A	Poisoning/Toxic Effects of Drugs & Other Substances W Cat or Sev CC	66	21	1.1705
X62B	Poisoning/Toxic Effects of Drugs & Other Substances W/O Cat or Sev CC	172	90	0.5305
	Total number of separations	**3,906**	**1,925**	
	Average costweight	**1.131**	**1.025**	
	Cost ($)	**22,945,812**	**10,245,827**	
	Total cost ($)	**33,191,638**		

Sources: Separations NHMD AIHW (2017b), costweights (Independent Hospital Pricing Authority, 2015) and AR-DRG codes Australian Consortium for Classification Development (2014).

[1] Cell counts less than 5 but not equal to zero are suppressed to protect confidentiality but are included in the total count.

CC = Complication and/or comorbidity: Cat = Catastrophic: OR = operating room: Proc = Procedures: Sev = severe: W = with: W/O = without.

4.2.2 Cannabinoid hyperemesis syndrome

Cannabinoid hyperemesis syndrome (CHS) is a syndrome linked with daily long-term cannabis use and is associated with symptoms such as nausea, vomiting, and sharp abdominal pains that are usually cyclic in nature (Bhatt and Queen, 2019; Chocron et al., 2019; Sorensen et al., 2017). A defining characteristic of this syndrome is a history of compulsive hot showers to help mitigate these symptoms. There were 670 hospitalisations in 2015/16 with a principal diagnosis of nausea and vomiting, coupled with a cannabis-related code in an additional diagnosis. There were a further 462 hospital separations where nausea and vomiting together with cannabis-related codes were identified in additional diagnosis, however these were not counted in this report due to other conditions being identified as the principal diagnosis for the hospital separations. The total cost of CHS separations was **$1.8 million** ($0.95 million for males and $0.85 million for females) (Table 4.3).

Table 4.3: Number of hospital separations and costs associated with cannabinoid hyperemesis syndrome identified by hyperemesis syndrome in principal diagnosis and cannabis-related code in additional diagnosis, 2015/16

	Male	Female	Total
Total number of separations	370	300	670
Attributable fraction	1	1	
Average costweight	0.496	0.549	
Total Cost ($)	**953,383**	**855,338**	**1,808,721**

Sources: NHMD (Australian Institute of Health and Welfare, 2017b) and costweights (Independent Hospital Pricing Authority, 2015).

4.3 Hospital separations indirectly attributable to use of cannabis

To estimate the cost of hospital separations related to other conditions as a complication from cannabis use, we calculated AF from the below formula:

$$AF = \frac{p(RR-1)}{p(RR-1)+1}$$

Where:

p = the prevalence of the risk factor; and'
RR = the relative risk of incidence of the disease of the exposed over the non-exposed.

Providing that the disease is uncommon, the OR will approximate the RR (Cornfield, 1951). For conditions where a RR was not available, we used the available OR to calculate the AF.

4.3.1 Chronic bronchitis

Research shows that smoking cannabis is harmful for lung health causing airway injury that can lead to serious lung damage (Hall et al., 2019b; Ribeiro and Ind, 2016; Tashkin, 2013). A significant positive association was observed between cannabis use and chronic bronchitis.

Due to the lack of an available RR, we used Aldington et al.'s (2007) OR estimate of 2.0 (95% CI 1.4 - 2.7) for chronic bronchitis for cannabis use *versus* non-smokers to calculate the AF for chronic bronchitis from cannabis smoking. Low and high bound estimates were calculated based on the lower and upper bound of the estimated OR.

There were 337 hospitalisations in 2015/16 with a principal diagnosis coded to chronic bronchitis for patients aged 15 years or older. We estimated that 2.2 (1.4 male and 0.8 female) of the chronic bronchitis separations could be attributable to cannabis use. The total cost of these separations was **$9,756** ($5,538 for males and $4,217 for females) (Table 4.4).

Table 4.4: Number of hospital separations and costs associated with cannabis-related chronic bronchitis, 2015/16

Condition		Male			Female		
	15-49	50-69	70+	15-49	50-69	70+	Total
Bronchitis							
Total separations	13	72	65	33	69	85	337
Attributable fraction							
Central estimate	0.026	0.013	0.001	0.013	0.005	0.000	
Low bound	0.011	0.005	0.001	0.005	0.002	0.000	
High bound	0.044	0.022	0.002	0.023	0.009	0.000	
Attributable separations							
Central estimate	0.34	0.96	0.09	0.45	0.36	0.02	2.22
Low bound	0.14	0.39	0.04	0.18	0.15	0.01	0.89
High bound	0.57	1.61	0.16	0.75	0.62	0.03	3.73
Average costweight		0.767			0.983		
Cost ($)							
Central estimate		**5,538**			**4,217**		**9,756**
Low bound		2,236			1,697		3,933
High bound		9,314			7,122		16,436

Sources: NHMD AIHW (2017b) and costweights (Independent Hospital Pricing Authority, 2015). Attributable fractions – author calculations

4.3.2 Depression, schizophrenia and other psychosis outcomes

People who use cannabis are more likely to develop depression, schizophrenia and other psychosis outcomes than those who have never used cannabis, and the association is stronger for those who use cannabis heavily/daily (Hall et al., 2019b; Marconi et al., 2016; Vaucher et al., 2018).

In the current literature, there was no available pooled RR for depression, schizophrenia and other psychosis outcomes due to cannabis use, thus we used available OR to estimate the RR in calculating the AF. Lev-Ran el al. (2014) in their systematic review estimated the OR for heavy cannabis use (an exposure measure of (1) DSM-IV cannabis use disorder or (2) at least weekly) and developing depression to be 1.62 (95% CI 1.21 - 2.16) compared to those who do not use cannabis or use it lightly (less than weekly). A meta-analysis of 10 studies conducted by Marconi et al. (2016) estimated an OR of 3.90 (2.84 to 5.34) for the risk of schizophrenia and other psychosis-related outcomes with heavy cannabis use compared to non-use. Age group- and gender-specific AF were calculated using the prevalence of at least weekly use from the NDSHS data (Australian Institute of Health and Welfare, 2017i).

To identify hospital separations due to depression, schizophrenia and other psychosis outcomes we used a combination of search methods. Firstly, we searched for condition-related ICD-10-AM codes in the principal diagnosis (see Table 4.1). In this way we identified 112,092 depression-related separations and 84,694 separations related to schizophrenia and other psychosis outcomes among patients aged 15 years or older. Next, we searched for AR-DRG codes specific to schizophrenia and acute psychiatric disorders (U61A, U61B, U62A, U62B) amongst the drug-related Tasmanian records with missing principal diagnoses. We identified a further 224 separations which gave a total of 84,918 hospitalisations related to schizophrenia and other psychosis outcomes.

We estimated that 2,028 (1,076 male and 952 female) of the depression-related hospital separations and 3,812 (2,621 male and 1,191 female) of separations related to schizophrenia and other psychosis outcomes could be attributable to cannabis use and the total cost of these separations was estimated to be **$88.5 million** ($63.2 million for males and $25.3 million for females: Table 4.5).

Table 4.5: Number of hospital separations and costs associated with depression, schizophrenia and other psychosis outcomes, 2015/16

Condition	Male			Female			
	15-49	50-69	70+	15-49	50-69	70+	Total
Depression							
Total separations	18,569	13,948	4,914	39,271	24,391	10,999	112,092
Attributable fraction							
Central estimate	0.042	0.021	0.002	0.020	0.008	0.000	
Low bound	0.015	0.007	0.001	0.007	0.003	0.000	
High bound	0.076	0.038	0.004	0.036	0.014	0.000	
Attributable separations							
Central estimate	776.9	288.3	11.1	766.4	183.8	1.9	2028.4
Low bound	270.6	99.0	3.8	263.0	62.6	0.7	699.6
High bound	1402.5	529.9	20.7	1409.9	341.6	3.6	3708.2
Average costweight		1.631			1.321		
Total cost ($)							
Central estimate		**9,116,012**			**6,533,302**		**15,649,314**
Low bound		3,162,615			2,238,321		5,400,936
High bound		16,541,741			12,043,762		28,585,503
Schizophrenia and other psychosis outcomes							
Total separations	31,489	9,221	1,492	26,025	12,985	3,706	84,918
Attributable fraction							
Central estimate	0.072	0.038	0.004	0.038	0.015	0.001	
Low bound	0.047	0.024	0.003	0.025	0.010	0.000	
High bound	0.104	0.055	0.006	0.056	0.023	0.001	
Attributable separations							
Central estimate	2267.5	346.8	6.3	992.6	196.7	2.1	3812.0
Low bound	1477.6	223.1	4.0	638.7	125.5	1.3	2470.2
High bound	3276.3	509.5	9.4	1457.9	292.2	3.1	5548.3
Average costweight		3.98			3.03		
Total cost ($)							
Central estimate		**54,120,702**			**18,779,040**		**72,899,742**
Low bound		35,205,297			12,066,278		47,271,575
High bound		78,378,173			27,633,962		106,012,135
Grand total ($)							
Central estimate		**63,236,714**			**25,312,342**		**88,549,056**
Low bound		38,367,913			14,304,598		52,672,511
High bound		94,919,914			39,677,724		134,597,638

Sources: Separations NHMD AIHW (2017b) and costweights Independent Hospital Pricing Authority (2015). Attributable fractions – author calculations

4.3.3 Road crash injuries

Cannabis has a sedative effect and produces potentially significant acute impacts on cognitive and psychomotor skills necessary for driving. As a result, cannabis use prior to driving is associated with an increased risk of being in a road traffic crash, and an increased risk of being the culpable driver in the crash (Ch'ng et al., 2007; Drummer et al., 2003; Verstraete and Legrand, 2014). We used the estimated RR of driving motor vehicle injury 1-3 hours subsequent to cannabis use calculated by Hall and colleagues (RR 1.37) (Hall et al., 2019a; Hall et al., 2019b).

As noted in Section 3.3.2, estimates of the prevalence of driving whilst intoxicated by cannabis are variable, reflecting differences in the way the data are calculated. For this study we have used the reported prevalence of drivers testing positive to cannabis in a random series of tests conducted in Queensland, which found 1.3 percent of drivers tested positive to Δ^9-THC (Davey and Freeman, 2009). Also, as noted above, detection of cannabis does not in itself indicate the extent of impairment.

We identified a total of 43,227 hospitalisations in 2015/16 with a first recorded external cause coded to road crash injuries (see Table 4.1 for ICD-10-AM codes) for patients of all ages. We estimated that 616 (378 male and 238 female) of the hospital separations relating to road crash injuries were attributable to cannabis use by the at-fault driver. The total cost of these separations was estimated at **$5.0 million** ($3.4 million male and $1.6 million female) (Table 4.6).

Table 4.6: Number of hospital separations and costs associated with road crash injuries, 2015/16

Road crash injuries	Male				Female				
	<15	15-49	50-69	70+	<15	15-49	50-69	70+	Total
Total separations	1,473	16,548	5,741	2,763	829	9,118	3,620	3,135	43,227
Attributable fraction									
Central estimate		0.014				0.014			
Low bound		0.005				0.005			
High bound		0.022				0.022			
Attributable separations									
Central estimate	21.0	235.8	81.8	39.4	11.8	129.9	51.6	44.7	616.0
Low bound	7.9	88.3	30.6	14.7	4.4	48.7	19.3	16.7	230.6
High bound	32.7	367.2	127.4	61.3	18.4	202.3	80.3	69.6	959.2
Average costweight	1.151	1.708	1.814	1.849	1.093	1.137	1.430	1.586	
Cost ($)									
Central estimate	**125,494**	**2,091,750**	**770,709**	**378,067**	**67,065**	**767,575**	**383,104**	**368,076**	**4,951,838**
Low bound	46,989	783,211	288,576	141,559	25,111	287,402	143,445	137,818	1,854,111
High bound	195,412	3,257,152	1,200,103	588,704	104,429	1,195,223	596,547	573,147	7,710,716

Sources: Separations NHMD AIHW (2017b) and costweights Independent Hospital Pricing Authority (2015). Attributable fractions – author calculations

4.4 Conclusions

Conditions and external causes attributable to cannabis use are estimated to have caused 12,960 hospital separations in 2015/16, with a total cost of **$128.5 million** (with the cost estimate ranging from a low bound of $54.5 million to a high bound of $142.3 million) (Table 4.7). Hospital separations are much more frequent among males, accounting for 64 percent of the total number of separations and 70 percent of the total costs incurred.

Schizophrenia and other psychosis outcomes are the dominant cause of the hospital separation costs arising from cannabis use, with an estimated 3,812 separations at a cost of $72.9 million. The other substantial driver of costs was mental and behavioural disorder due to use of cannabinoids or cannabis (derivatives) poisoning with 5,831 separations at a cost of $33.2 million. However, caution should be exercised in comparing different causes, as the identification process meant that any separation that included a cannabis use or poisoning principal diagnosis, would be allocated to that category regardless of subsequent diagnoses or external causes.

Table 4.7: Hospital separations summary

Condition	Sex	Attributable separations			Cost		
		Central	Low bound	High bound	Central $	Low bound $	High bound $
Mental and behavioural disorder due to use of cannabinoids or cannabis (derivatives) poisoning	Male	3,906			22,945,812		
	Female	1,925			10,245,827		
Cannabinoid Hyperemesis Syndrome	Male	370.0			953,383		
	Female	300.0			855,338		
Chronic bronchitis	Male	1.4	0.6	2.3	5,538	2,236	9,314
	Female	0.8	0.3	1.4	4,217	1,697	7,122
Schizophrenia and other psychosis outcomes	Male	2,620.6	1,704.7	3,795.1	54,120,702	35,205,297	78,378,173
	Female	1,191.4	765.5	1,753.2	18,779,040	12,066,278	27,633,962
Depression	Male	1,076.4	373.4	1,953.1	9,116,012	3,162,615	16,541,741
	Female	952.1	326.2	1,755.1	6,533,302	2,238,321	12,043,762
Road crash injuries	Male	378.0	141.5	588.6	3,366,019	1,260,335	5,241,370
	Female	238.0	89.1	370.6	1,585,819	593,776	2,469,346
All cannabis-attributable conditions	Male	8,352	2,220	6,339	90,507,465	39,630,483	100,170,598
	Female	4,607	1,181	3,880	38,003,543	14,900,072	42,154,192
	Persons	**12,960**	**3,401**	**10,219**	**128,511,008**	**54,530,555**	**142,324,790**

Source: Separations NHMD AIHW (2017b)

Note - Where low or high bound estimates are not available, the central estimate was used to calculate the separations and cost totals for all cannabis-attributable conditions.

4.5 Limitations

There are some limitations related to administrative data and the methods of calculating costs. Caution should be practiced in the interpretation of the data presented in this Chapter and the following caveats should be considered:

- The overall number of hospital separations presented in this Chapter are likely to be underestimated;
- The prevalence of CHS amongst hospital patients is likely to be underestimated in the current study. Many patients who present to emergency departments are hospitalised everyday with symptoms that are similar to CHS symptoms but may not be queried about cannabis use. Without taking necessary history of using cannabis that would suggest CHS, the condition is likely to be misdiagnosed (Bhatt and Queen, 2019);
- The ICD-10-AM classification itself has limitations. We were unable to separate hospitalisations related to plant-based cannabis from those related to synthetic cannabinoids. Moreover, coding of administrative data depends on the quality of clinical documentation and the quality of the coding process itself and hence conditions may be under- or over-ascertained;
- There could be variations among jurisdictions and between private and public hospitals in the way in which hospital services are defined and coded;
- For 2015/16, almost all public hospitals and the great majority of private hospitals provided data for the NHMD. The exceptions were an early parenting centre and the private free-standing day hospital facilities in the ACT (Australian Institute of Health and Welfare, 2017b);
- The NHMD 2015/16 do not contain cross-border separations. Only separations where the patient's usual residence was within the state of hospitalisation were included;

- Tasmanian records accessed for 2015/16 only included those where there was a drug or alcohol related principal and/or additional diagnoses and external causes which enabled the identification of separations with other potentially drug-related conditions. As a result, these findings likely represent an underestimate of costs as Tasmanian records could not be used in the calculation of the indirectly attributed conditions;
- The NHMD 2015/16 dataset included 5,913 (0.06 percent) hospital separations with a missing principal diagnosis code and most of them (4,722) are for the records where the state of hospitalisation was Tasmania. In most of the cases, we were unable to identify the main reason for hospitalisation, even though we know they were potentially drug-related; and,
- Later, in Chapter 7, we used AF derived from the DUMA survey, which included attributions for violent crimes (Australian Institute of Criminology, 2019). We believe that it is justifiable to use these AF in calculating proximal costs, such as police time and court costs. It is more tenuous to assert that these AF apply to hospital separation costs, therefore we have not estimated hospital costs arising from interpersonal violence potentially attributable to cannabis use.

For more information on the NHMD, go to the ‘Admitted Patient Care 2015/16: Australian hospital statistics’ report (Australian Institute of Health and Welfare, 2017b).

Acknowledgments

We acknowledge the Australian Institute of Health and Welfare for data from the National Hospital Morbidity Database.

CHAPTER 5: OTHER HEALTH CARE COST

Aqif Mukhtar, Steve Whetton & Robert J. Tait

5.1 Background

People who use cannabis have a range of health and behavioural issues arising from its use, in particular, those who develop cannabis dependence. The use of cannabis is associated with accessing many types of health services, including hospital ED and outpatient services, GP, specialist care, ambulance services, nursing homes and other carer services. In addition, people who use cannabis are likely to incur further costs for drug treatment services and any use of pharmaceuticals for the treatment of cannabis-related conditions. The adverse health conditions incurred are also likely to have financial and other impacts on family members who act as carers. The costs arising from inpatient admissions are addressed in Chapter 4.

The Australian Government spent $70.2 billion on health care in 2015/16, with state, territory and local [12] governments contributing an additional $44.4 billion (Australian Institute of Health and Welfare, 2017f). Public hospitals received 40 percent of this spending, with primary care and community health receiving about 30 percent of government spending (Australian Institute of Health and Welfare, 2017f). Ambulance services received government funding of $3.2 billion (Steering Committee for the Review of Government Service Provision, 2018b). Households and businesses also fund a substantial portion of healthcare costs, particularly in primary care and allied health services. The total spending on healthcare in Australia was estimated to be $170.4 billion in 2015/16 (Australian Institute of Health and Welfare, 2017f).

Correct apportionment of these costs to cannabis use and related conditions was the first step towards estimating their overall costs. However, for most of these costs, such as general practitioner services, there is no unambiguous way of attributing costs to cannabis as there is no consistent and reliable equivalent to the ICD-10-AM coding used for hospital separations. The same limitation was also encountered in recent studies calculating societal costs for methamphetamine, tobacco and extra-medical opioids use (Whetton et al., 2016; Whetton et al., 2019; Whetton et al., 2020). To address this, in calculating the overall cost of tobacco to Australian society, the assumption was made that the proportion of other health costs attributable to tobacco could be reasonably approximated by the proportion of hospital bed-days attributed to tobacco on the basis that they had a similar distribution of underlying causes (Collins and Lapsley, 2008; Whetton et al., 2013). We have used this approach as the starting point in calculating the healthcare costs attributable to cannabis use.

However, there are likely to be potentially significant differences between the forms of injury and ill-health driving hospital separations and those driving some of the other healthcare costs. For example, many GP visits are for reasons unrelated to those which cause hospital separations, such as renewal of prescriptions, general health check-ups and vaccinations.

Further, some components of allied health expenditure must be attributable to cannabis use or dependence. For example, this cohort is at increased risk of accidental injury from road traffic accidents (Els et al., 2019; Rogeberg, 2019) due to poor judgement and decision making, potentially requiring them

[12] Health expenditure data are not collected separately from local government authorities. If local government authorities received funding for health care from the Australian Government or state and territory government, this expenditure is included as expenditure from that body. Own source funding by local government authorities is not included.

to use out-of-hospital rehabilitation services. Other problems include mental health conditions such as depression and psychotic disorders (Lev-Ran et al., 2014; Marconi et al., 2016), potentially increasing the number of GP visits among this cohort. Other than GP costs, none of these forms of allied health expenditure potentially attributable to cannabis use was able to be quantified using current data, and of allied health spending, only GP costs were included here.

This left the following areas of other healthcare costs for inclusion in this analysis:

- Ambulance costs;
- Non-admitted hospital care costs (ED and outpatient services);
- Primary healthcare costs, including GP visits and specialist visits;
- Community mental health and specialist drug treatment services;
- Pharmaceuticals for cannabis-attributable diseases or conditions;
- Residential and other aged-care services; and,
- Costs to family members of providing care.

In each of these cases, we have initially taken the share of cannabis-attributable hospital costs as the base for cannabis-attribution. We then adjusted that figure where possible, to reflect other evidence about the factors driving demand for that form of health service.

In 2015/16, total expenditure on hospital separations was $28.3 billion (Independent Hospital Pricing Authority, 2018). Cannabis-attributable hospital separations are estimated to have had a total net cost of **$128.5 million** (Table 4.7), giving a cost share of **0.45 percent**. This then represents the base cost share we selected for other medical costs, to be adjusted from other evidence on the source of costs when these are available. A main cost estimate and a high and low bound are also presented where feasible.

5.2 Ambulance costs

In 2015/16, there were 1.8 million ED presentations where the arrival mode was recorded as ambulance, air ambulance or helicopter rescue service (Australian Institute of Health and Welfare, 2016b). In addition, there were 289,746 intra-hospital transfers for acute patients (Australian Institute of Health and Welfare, 2017b). Assuming that all intra-hospital transfers for acute patients used an ambulance service, the total ambulance activity in 2015/16 was estimated to be 2.1 million transfers. The total 'patient transport' expenditure in 2015/16 was $3.7 billion (Australian Institute of Health and Welfare, 2017f). Therefore, the average cost of an ambulance transfer was calculated as $1,776.

It was not possible to estimate the cannabis-related ambulance episodes from the available data as the data do not report numbers at the individual drug level. A research study in Victoria (Australia) estimated the rate of cannabis-related ambulance attendances in 2013 to be 5.5 per 100,000 population (Kaar et al., 2015). After applying that rate to the Australian estimated resident population of 23.9 million in December 2015 (Australian Bureau of Statistics, 2018b), we calculated 1,317 estimated cannabis-related ambulance attendances with a total cost of $2.3 million. We used this as the low bound estimate for ambulance costs.

Given the similarity of the population they serve, the proportion of ambulance costs attributable to specific causal factors is likely to be broadly similar to that of hospital separations. Thus, the proportion of hospital separation costs attributable to cannabis use should provide a reasonable proxy for the proportion of ambulance costs that can be attributed to this cohort of patients (0.45%).

As mentioned above, the total ‘patient transport’ expenditure in 2015/16 was $3.7 billion. Applying the cost share from the hospital separations data, this suggests that the cannabis-attributable cost of ambulance service was $16.9 million. This forms the high bound for ambulance costs. We used the mean of the low and high bound values as our central estimate of **$9.6 million** (Summary Table 5.6).

5.3 Emergency department presentations

Acute cannabis toxicity often requires presentation to a hospital ED. Toxicity could be due to cannabis only or combination of cannabis and other depressant drugs, often also combined with alcohol. In such cases, only one drug is listed as the principal drug of concern, resulting in potential undercounting of ED presentations for a particular drug. This also makes it difficult to get accurate data and costings for a specific drug.

The available hospital ED presentations data did not have sufficient granularity to allow accurate estimates of cannabis-attributable ED presentations, especially when many of the patients who present at ED were poly-drug users. Therefore, we had to rely on the assumption that the proportion of hospital separation costs attributable to cannabis use should provide a reasonable proxy for the proportion of ED presentations that can be attributed to this cohort of patients.

The total expenditure in 2015/16 on ED presentations which do not result in an admission to hospital was $4.7 billion (Independent Hospital Pricing Authority, 2018). Applying the cost share from the hospital separations data suggests that the cannabis-attributable cost of ED presentations was **$21.3 million**, being the central cost estimate. (We did not separately estimate low and high bound values).

5.4 Non-admitted patient care

In 2015/16, about 33.4 million non-admitted patient care service events (previously referred to as outpatients) were provided by Australian hospital systems (Australian Institute of Health and Welfare, 2017a). Of these, 860,772 (2.6%) service events were provided by alcohol and other drug clinics. The proportion of cannabis-related (F12 - Mental and behavioural disorders due to use of cannabinoids) out of total hospital separations under the ICD codes category F10-F19 (Mental and behavioural disorders due to psychoactive substance) use was 6.4 percent (Australian Institute of Health and Welfare, 2017b). Applying this proportion to 860,722 non-admitted patient service events for alcohol and other drugs clinics resulted in 55,029 estimated cannabis-related non-admitted patient service events. The unit cost of a service event in 2015/16 was $303 (Independent Hospital Pricing Authority, 2018), resulting in a low bound cost of $16.7 million for cannabis-related non-admitted patient care.

The total expenditure on non-admitted patient care in 2015/16 was $5.4 billion (Independent Hospital Pricing Authority, 2018). Applying the cost share from the hospital separations data (6.4%) suggests that the cannabis-attributable cost of non-admitted patient care was $344.7 million. This forms the high bound for non-admitted costs. We used the mean of the low and high bound values as our central estimate of **$180.7 million**.

5.5 Primary health care

Dependence on cannabis is associated with a range of health problems that may require treatment from a GP or other primary care physician. These include medical and psychological complications that may require a long-term care plan. Reviewing data from the Bettering the Evaluation and Care of Health (BEACH) survey (Britt et al., 2016) there appears to be at least 19.4 percent of GP visits that should be excluded from the calculation as wholly or largely unrelated to the conditions that result in hospital separations (e.g. visits for prescriptions, general check-ups and administrative visits).

In-scope ‘un-referred medical services’ are estimated at $9.5 billion (total ‘un-referred medical services spending’ was $11.8 billion in 2015/16, with 19.4% of this spending excluded as it related to ineligible costs identified from the BEACH data (Australian Institute of Health and Welfare, 2017f)). Applying the cost share from the hospital separations data (0.45%) suggests that the cannabis-attributable cost of the in-scope ‘un-referred medical services’ was $42.9 million, making the low bound cost estimate. The high bound estimate was calculated as $53.3 million, being 0.45 percent of the total ‘un-referred medical service’ expenditure. The average of these two estimates, **$48.1 million** was taken as our central estimate.

There was additional expenditure of $17.7 billion in 2015/16 for ‘referred medical services’, e.g. specialist physicians (Australian Institute of Health and Welfare, 2017f). It is not clear whether this should be factored down on a similar basis to costs for GP. Our high estimate of referred medical services was calculated from the unadjusted expenditure, on the basis that the reasons why patients were referred to specialists were likely to be closer to the reasons for hospital separations than to the reasons for visits to GP. For our low bound estimate of costs, we factored referred medical service costs down on the same basis as for un-referred medical service costs, giving in scope costs of $14.3 billion.

Applying the cost share from the hospital separations data to the unadjusted referred medical service costs gives a high bound estimate of cannabis-attributable costs as $80.3 million, and a low bound, calculated from the adjusted spending, as $64.7 million. The mean of these two estimates, **$72.5 million** was taken as the central estimate. For the overall cost of primary care (GP plus specialist care), see Table 5.6.

5.6 Specialist drug treatment services

Data on the number of cannabis-related treatment episodes were obtained from AIHW – *Alcohol and other drug treatment services in Australia.* (Australian Institute of Health and Welfare, 2017d). Costs by treatment type and episode were obtained from a range of sources such as Australian State health departments, personal contacts and previous research. Costs per episode by treatment type, specifically for cannabis use dependence were not available. Therefore, the average costs were multiplied by the relevant frequency of episodes of care. The alcohol and other drug treatment services (AODTS) data also contain information on individuals who seek treatment or support for themselves as a consequence of another person’s drug use.

In 2015/16, about 796 alcohol and other drug treatment services provided just over 206,600 treatment episodes, with 96 percent (n = 198,747) of treatment episodes being for ‘own drug use’. Of these, 22.7 percent (n = 45,099) of treatment episodes were for cannabis.

Table 5.1: Costs of treatment episodes – cannabis primary drug 2015/16 – own use

Treatment type		Number of episodes	Cost per episode ($)	Costs ($)
Withdrawal		**4,217**		
	Non-residential [1]	*2,050*	4,979.28	10,207,524
	Residential [1]	*2,167*	7,539.63	16,336,202
Rehabilitation		**1,446**		
	Non-residential [1, 2]	*426*	2,077.61	884,635
	Residential [1]	*1,020*	7,538.63	7,689,398
Counselling [1]		17,232	2,076.61	35,784,098
Support & case management only [3]		4,753	1,801.95	8,564,649
Information & education only [3]		10,376	379.74	3,940,186
Assessment only [3]		5,603	116.52	652,879
Pharmacotherapy and other [1]		1,472	2,076.61	3,056,766
Total		**45,099**		**87,116,336**

Sources: [1] Mental Health Commission(2015); [2] Personal communication TK(2015); [3] Ngui(2010);

Note: these data do not include visits to GP or other health care provided in community mental health which are captured elsewhere in the Chapter.

Average treatment costs for different treatment types were replicated from a previous study where they had been sourced from public data (Mental Health Commission, 2015) and a personal communication (TK, 2015). The 2013/14 figures were adjusted to 2015/16 using a CPI calculator (Australian Bureau of Statistics, 2019c). There were 1,472 episodes listed as 'other including pharmacotherapy': it was unclear what pharmacotherapy would be involved in this treatment and thus we were unable to estimate its cost. Therefore, we costed these episodes at the same price as counselling, since there were resource implications for these service events. The actual cost of medications resulting from such events should be covered in the cost of pharmaceuticals in Section 5.7. Overall, the total cost of treatment for own use of cannabis was $87.1 million (Table 5.1).

Individual proportions by treatment type from AODTS data were then applied to the total of those who were seeking assistance due to others' drug use. The same average costs of treatment were applied to these episodes.

Table 5.2: Costs of treatment for those seeking treatment due to others' cannabis use, 2015/16

Treatment type	Episodes - 'seeking treatment for others' cannabis use (% of total episodes)	Episodes - 'seeking treatment for others' cannabis use (n)	Costs ($)
Counselling*	7.42	1,279	2,655,821
Support & case management only	2.65	126	227,380
Information & education only	4.93	511	194,121
Assessment only	1.29	72	8,423
Total		**1,989**	**3,085,745**

Source: Australian Institute of Health & Welfare (2017d)

Note: these data do not include visits to general practitioners or other health care provided in community mental health which are captured elsewhere in the chapter

To calculate treatment episodes for clients who were seeking treatment for 'other's drug use' such as a family member, relative or friend, where that person had cannabis as their primary drug of concern, we applied individual proportions out of the total by treatment types. The additional cost of episodes was for cannabis use by others was $3.1 million (Table 5.2). The total costs of other specialist and drug treatment services for cannabis-related cases was **$90.2 million** (Table 5.3).

Table 5.3: Total expenditure on treatment for cannabis at specialist treatment centres, 205/16

Client Type	Costs ($)
Treatment for own use	87,116,336
Treatment for others' use	3,085,745
Total	**90,202,082**

Source: Australian Institute of Health & Welfare (2017d)

Note, we chose not to apply the hospital cost share as an alternative calculation method because the share of cannabis-related episodes in alcohol and other drug treatment services was around 23 percent i.e. 45,099 cannabis-related episodes out of 198,447 total AODTS episodes. By comparison, the share of cannabis-related hospital separations was only 0.45 percent out of total inpatient episodes. Given that the total cost of drug treatment service episodes was $443.2 million, applying the hospital separation cost share method, the cost of cannabis-related drug treatment service episodes would only be around $2.0 million. If we take this as a low bound estimate, the central estimate would be $46.1 million, effectively reducing the directly calculated cost by almost 50%

5.7 Cost of pharmaceuticals prescribed for illicit cannabis-attributable conditions

Pharmaceuticals used in treating cannabis-related conditions, received during a hospital admitted episode, are included within the costs derived from diagnosis-related grouping codes, and form part of the costs reported in Chapter 4. Therefore, only the cost for treatment of cannabis-related conditions outside the hospital system needs to be estimated. Previous estimates have determined the net cost by adjusting for premature deaths in the target group, for example tobacco smokers (Whetton et al., 2019) by subtracting saving from premature deaths among tobacco smokers. The same approach was used in this instance, with the notional future savings reported in Chapter 3 with the mortality estimates.

As noted in Section 2.2, cannabis-attributable conditions were identified via a recent review (Hall et al., 2019b). The conditions identified through this process were: cannabis use disorders, depression, schizophrenia and other psychosis, motor vehicle accidents, transport injuries, low birthweight and cannabinoid hyperemesis syndrome (CHS). Finally, chronic bronchitis was included on the basis of the analysis by Aldington et al., (2007).

Antidepressant drugs were identified via the PBS website under the category of 'Antidepressants'. Similarly, the drugs used to treat psychosis and schizophrenia were also identified using the PBS website under the category of 'Antipsychotics' (Pharmaceutical Benefits Scheme, 2018b). For CHS, the patient would need to stay in hospital for a short period of time as treatment is largely hospital based. Therefore, the CHS cost should be covered either as an inpatient (Chapter 4) or as an ED attendee in Section 5.3. Conditions such as transport injuries and motor vehicle accidents were too broad or generic to be associated with a specific list of medications, especially to narrow it down to individuals who use cannabis. Part of such costs is covered in cannabis-attributable cost of road crashes (Chapter 8).

Since chronic bronchitis comes under the umbrella of chronic obstructive pulmonary disease (COPD), the treatment of chronic bronchitis follows the same general principles as treatment of COPD. Therefore, drugs used for COPD 'only' treatment were used for calculating pharmaceutical costs for chronic bronchitis as well. In addition, we also added 20 percent for the pharmaceutical costs for treating COPD plus asthma. Further details, such as individual drug names and overlap between COPD and asthma are given in a previous social cost of illness study focusing on tobacco use in Australia (Whetton et al., 2019). The share of hospital costs for cannabis-attributable chronic bronchitis was calculated as the cost of cannabis-attributable separations for chronic bronchitis divided by the total cost of hospital separations for chronic bronchitis plus the total cost of separations for COPD.

In January 2016, the co-payment costs for prescription medications were $6.20 for concessional patients and $38.30 for general patients (Pharmaceutical Benefits Scheme, 2016a). When general patients reach their safety net threshold, they then pay $6.20 per prescription and when concessional patients reach their threshold, they make no co-payment. Co-payments for those covered by the Repatriation Schedule of Pharmaceutical Benefits (RPBS) depend on which Department of Veterans' Affairs concessional card they hold. Gold and Orange card holders receive the concessional rate on all listed medications, while those on the White card can receive the concessional rate on medications for their service related condition(s) (Department of Veterans' Affairs, 2018). The maximum co-payment is $6.20: when safety net thresholds are reached there are no further co-payments. We applied these values to the 'service' (e.g. number of prescriptions) data from the PBS (Pharmaceutical Benefits Scheme, 2016b) to calculate the co-payment costs.

For each medication (PBS item number) listed in Appendix 5.1, government costs in terms of Services (n) and Benefits ($) were extracted from the PBS website and co-payments estimated from the associated patient benefit categories (Pharmaceutical Benefits Scheme, 2016b). We were also able to estimate the cost of pharmaceutical drugs that were priced below the general co-payment level by accessing the data for costs of under co-payment prescriptions from the PBS website (Pharmaceutical Benefits Scheme, 2019). These costs are extra to the government borne pharmaceutical costs. Those with cannabis use disorders seek help for a range of physical and mental health conditions, but may not disclose their use of cannabis at the consultation (Copeland et al., 2001; Copeland, 2016).

Table 5.4: The total costs of medications for key cannabis-related conditions, 2015/16

Condition	Above Co-Payment cost ($)	Under Co-Payment Cost ($)	Total Cost ($)
Psychosis and Schizophrenia	309,992,367	6,450,892	316,443,259
Depression	302,371,439	165,125,738	467,497,176
Chronic Bronchitis	246,215,672	5,107,828	251,323,500
Total	**858,579,478**	**176,684,457**	**1,035,263,935**

Source: Pharmaceutical Benefits Scheme (2016b).

We did not have access to age-group or sex for the PBS costs and so could not apply the cannabis AF for each condition directly to pharmaceutical costs. Instead we assumed that the proportion of pharmaceutical cost for each condition attributable to cannabis would be equivalent to the proportion of total hospital separation costs attributable to cannabis for that condition, which is effectively the age, gender and severity weighted AF for that condition. This gives a total cost of cannabis-attributable PBS/RPBS listed medicine costs for the selected conditions of $24.3 million (Table 5.5), considered as the low bound estimate.

Table 5.5: The costs of medications [a] for key cannabis-related conditions and cannabis-attributable costs, 2015/16

Condition	Cannabis-attributable hospital separation costs (%)	Cannabis-attributable PBS medicine costs ($)
Psychosis and Schizophrenia	4.49%	14,205,143
Depression	1.81%	8,459,914
Chronic Bronchitis	0.66%	1,652,881
Total		**24,317,937**

Source: Pharmaceutical Benefits Scheme (2016b).

[a] For individual items number see Appendix 5.1: Costs do not include medications dispensed 'in-hospital' or to 'out-patients'.

The costs presented in Table 5.5 only include the cost of prescribed medications outside the hospital sector. Therefore, the total estimate does not include 'in-hospital' pharmaceutical costs (these are included in the hospital separation costs reported in Chapter 4), nor does it include pharmaceuticals delivered through outpatient hospital clinics. These latter costs should be captured in the non-admitted hospital costs calculated above.

As an alternative approach, we also calculated pharmaceutical costs using the same approach as for outpatient hospital costs, i.e. allocating a share of total PBS listed pharmaceutical costs equal to the share of cannabis-related inpatient separations. In 2015/16 the total cost of PBS and RPBS medications was $10.4 billion, with a further $1.5 billion in gap payments (total $11.9 billion) (Pharmaceutical Benefits Scheme, 2018a). Assuming that the proportion of PBS listed pharmaceutical costs attributable to cannabis matched the share of hospital separation costs in 2015/16, it gives an estimate of pharmaceutical costs of $54.0 million, considered as the high bound estimate. The mean of the low and high bound values was taken as the central estimate of **$39.1 million** (Table 5.6).

5.8 Community mental health services

The total expenditure on community mental health care services in Australia during 2015/16 was $2.05 billion. There was also expenditure of $49.1 million on the national suicide prevention program (Australian Institute of Health and Welfare, 2019a). However, there is continued uncertainty as to the strength of any potential link between cannabis use and suicide (Hall et al., 2019a; Hall et al., 2019b): for acute cannabis use there is little evidence of increased imminent risk of suicide, while chronic use may be predictive, but findings are not compelling with known confounders often unaddressed (Borges et al., 2016). Thus, we have excluded these costs from the calculation.

The number of service contacts and the costs of community mental health expenditure data were sourced from the AIHW report providing statistics for mental health services in Australia (Australian Institute of Health and Welfare, 2019a). During 2015-16, around 9.4 million community mental health care service contacts were provided to approximately 414,000 patients across Australia. Of these, 27,881 (0.3%) service contacts were for the principal diagnosis 'Mental and behavioural disorders due to use of cannabinoids (F12)'. This gives a low bound cost of $6.1 million.

The high bound cost was estimated from the total cost of hospital separations for mental and behavioural conditions, plus treatment for issues arising from substance use (AR-DRG codes U40Z through V66Z), which had a total cost of $1.8 billion. Of these separations, 6.6 percent were due to cannabis-related conditions, at a cost of $121.7 million. Applying the same percentage to the community mental health budget gives a high bound of $134.8 million and thus a central estimate of **$70.5 million** (Table 5.6).

5.9 Residential and other aged-care services

High-level residential care (previously known as nursing home care) is likely to include a proportion of people with health conditions attributable to cannabis. Many older patients remain in hospital while waiting for access to residential aged care: in 2015/16 it was estimated that this period was 11.3 days per 1,000 patient days (Steering Committee for the Review of Government Service Provision, 2018a) [13]. These days in hospital are included with other hospital costs and are reported in Chapter 4. Furthermore, until 2005/06, high-level residential services were classified with health services but were subsequently counted with welfare services, so caution is required in assessing changing expenditure over time within categories (Australian Institute of Health and Welfare, 2017f).

Residential care data (excluding expenditure on high-level residential care for younger people with disability were extracted from the *Community Services* report on aged-care (Steering Committee for the Review of Government Service Provision, 2017a)). This item accounted for over two-thirds of the total aged-care expenditure ($11.5 of $16.8 billion) with other services such as home care and other support services accounting for the remainder. As only data on ***Government*** expenditure on aged-care services is available it is likely that these costs will be underestimates.

Data from the AIHW suggest that 53 percent of nursing home residents suffer from some form of dementia (Australian Institute of Health and Welfare, 2012). We have assumed that those with dementia would be in nursing home care regardless of other conditions and so have excluded them from the calculation of cannabis-attributed costs. Discounting the expenditure on high level residential care to exclude patients who have dementia gives potentially in scope government costs of $5.5 billion.

Other aged-care services have total government expenditures of $5.1 billion. Assuming that a similar proportion of other aged-care costs are attributable to dementia, this gives in scope government costs of $2.4 billion. Applying the cost share from the hospital separations data suggests that the cannabis use attributable cost to government of high-level residential care was **$24.8 million** and the attributable cost to government of other aged-care services was **$10.7 million.** Due to the lack of data on the extent of cannabis dependence and associated health problems within the aged-care sector, we have only included these cost items in the high bound estimate.

5.10 Informal carers

To the extent that informal carers reduce the demand on formal care they make an economic contribution by reducing government costs (Oliva-Moreno et al., 2017). A recent systematic review of the contribution by informal carers in caring for those with chronic conditions, found that those caring for people with dementia made the highest contribution (estimated in Euros - EUR 21,065 per year) followed by mental illness (EUR 15,416) (Oliva-Moreno et al., 2017). However, the cost of substance use disorders, as a subset of mental health disorders, was not reported. Other than a recent report on the costs associated with tobacco use, where the estimate was $2.0 billion in 2015/16 (Whetton et al., 2019) and the estimate of the cost relating to extra-medical opioids ($62.3 million (Whetton et al., 2020)) we have yet to identify any studies estimating the value contributed by informal carers to health conditions caused by alcohol or illicit drugs.

In estimating the cost of informal care for those with ill-health due to cannabis use, two methods were used to provide the high and low bound estimates, with the mean used as the central estimate. In Australia, the total value of informal care was assessed at $60.3 billion in 2015. This involved 825,000

[13] These data on hospital days come from the 2018 report; costs come from the 2017 report.

persons who were primary carers of someone impaired due to disability or ageing: there were an additional 2,032,000 Australians who reported that they were a non-primary carer (Deloitte Access Economics, 2015). The economic contribution of carers will tend to vary with the severity of the condition of the person being cared for. It is likely that those with more severe conditions will require more hours of care per week. In 2015, it was estimated that the average cost across level of severity was $70,362 per person per year (Deloitte Access Economics, 2015).

From confidentialised unit record file data on Disability, Ageing and Carers, the following primary conditions were included in the unit record data in a disaggregated form [14] and were at least partially caused by cannabis use (Australian Bureau of Statistics, 2017b) [15]:

- Schizophrenia and other psychoses; and
- Depression / mood affective disorders.

In each case, the number of persons reporting that they received informal assistance for activities was adjusted to reflect the cannabis-attributable cases for that condition (schizophrenia and other psychosis 0.028%, depression 0.015%).

There were 320 persons reporting that they needed informal assistance at least once per week due to a cannabis-attributable condition, or 0.14 percent of the total persons reporting needing informal assistance at this frequency for any condition. We applied the average cost ($70,362 per person per year (Deloitte Access Economics, 2015)) to obtain the cannabis-attributed low bound cost of $22.8 million.

To calculate the high bound cost, we multiplied the share needing at least weekly care for cannabis conditions (0.085%) by the total value of informal care in Australia ($60.3 billion), which gave a total of $83.9 million. The mean of the low and high bound gave the central value for informal care of **$53.4 million** (Table 5.6).

5.11 Conclusions

This chapter presented health costs in primary care and for other health costs for non-admitted treatment. The estimated total healthcare cost attributable to cannabis use was **$585.4 million** in 2015/16 (Table 5.6). If we exclude the cost of $53.3 million attributed to informal care, the healthcare costs are around $532.1 million. These costs are considerably greater than those for inpatient care ($128.5 million). The continuing emphasis on reducing length of hospital inpatient stays, given the demand for beds and the costs of inpatient care (Australian Institute of Health and Welfare, 2017b) means that the relative cost of out-of-hospital care is likely to increase in the future. Including an additional valuation for care provided by family members, substantially increases the cost of cannabis use to society.

---

[14] A number of conditions caused by cannabis, (e.g. motor vehicle accidents / transport injuries, cannabis use disorders) were not reported separately in the data, and therefore could not be included in the calculation.

[15] Chronic bronchitis was excluded from this calculation as it was not possible to identify the full set of conditions coded as 'Other respiratory disorders' in the survey of Disability, Ageing and Carers and therefore we could not estimate the share of costs that should be allocated to chronic bronchitis.

Table 5.6: Summary of other health costs

Cost area	Central estimate ($)	Low bound ($)	High bound ($)
Ambulance costs	9,628,231	2,338,183	16,918,278
Emergency Department costs	21,349,728		
Non-admitted patient care costs	180,705,870	16,673,682	344,738,058
Primary healthcare – Total	120,597,976	107,644,911	133,551,040
Primary healthcare - GP Visits	*48,112,288*	*42,944,692*	*53,279,884*
Primary healthcare - Referred Medical services	*72,485,687*	*64,700,219*	*80,271,156*
Specialist healthcare and drug treatment services cost [a]	90,202,082		
Pharmaceuticals for cannabis-related conditions	39,153,521	24,317,937	53,989,104
Community mental health and suicide prevention	70,452,266	6,066,114	134,838,417
High-level residential care			24,806,453
Aged care			10,695,950
Informal carers	53,353,516	22,822,620	83,884,413
Total	**585,443,189**	**291,415,257**	**914,973,523**

Notes: Central estimates have been used to calculate totals where low or high bound costs are not available except for aged / high level care which are in the high bound estimate only.

[a] See section 11.4 for an alternative method of calculation: GP = general practice.

In 2015, about 2.7 million Australians were informal carers, including 856,00 who were primary carers for a person with a health condition or disability (Australian Bureau of Statistics, 2016b). Some of the conditions partly contributed to by cannabis use, such as schizophrenia, or traffic accident injuries were either chronic or may involve extended treatment and recovery outside the hospital system, although treating clinicians may not be aware of their cannabis use (Copeland et al., 2001; Copeland, 2016). As such, assistance may be required from a partner/relative or significant other. We believe that this is the first attempt to qualify these informal care costs in relation to cannabis. From international evaluations of the costs from specific conditions, it is evident that the input from informal carers effectively accounted for significant savings to the health budget. For example, the informal contribution to caring for stroke patients was estimated at 27 percent of the total economic cost of stroke (Saka et al., 2009).

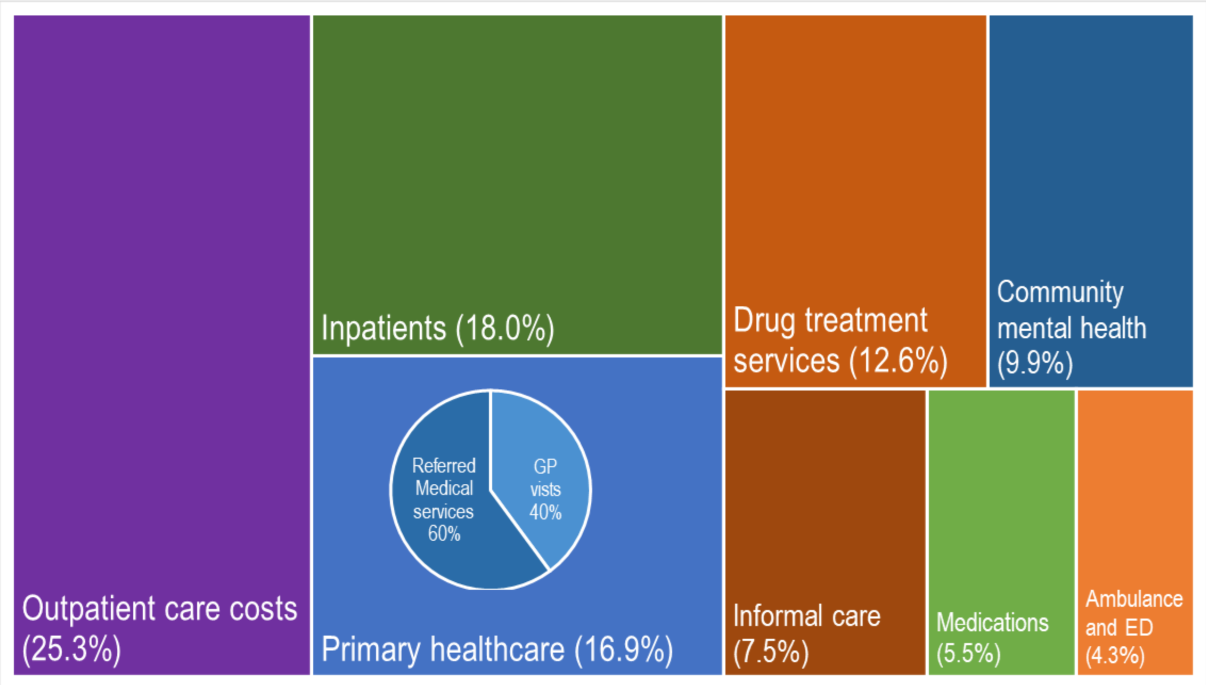
Table 5.7 summarises all the healthcare related costs mentioned in Chapters 4 and 5 and the proportion of cost attributable to cannabis. Aged-care is not included as its costs are considered for the high bound estimate only. Overall, the total relevant healthcare expenditure during 2015/16 was $146.3 billion. Out of that, **$714** million was attributable to cannabis-related conditions (0.5 percent of the total). Figure 5.1 shows the percentage of costs in each part of the health-care system attributable to cannabis-related illness.

Table 5.7: Cannabis-attributable cost share of total expenditure for healthcare services, 2015/16

Item	Cannabis-attributable (million $) [a]	Total health expenditure (million $)	Cannabis-attributable Share (%)
Hospital Separations	129	28,348	0.5%
Ambulance and ED	31	8,442	0.4%
Outpatient care costs	181	5,392	3.4%
Drug treatment services	90	443	20.4%
Primary healthcare	121	29,460	0.4%
Medications	39	11,909	0.3%
Community mental health	70	2,047	3.4%
Informal care	53	60,272	0.1%
Total healthcare related expenditure	**714**	**146,314**	**0.5%**

ED = emergency department

Figure 5.1: Sources of cannabis attributable costs across the health sector including informal carers



ED = emergency department: GP = general practice

5.12 Limitations

Compared to inpatient separations, allocating episodes of care for most out-of-hospital treatment/care is subject to a greater degree of uncertainty due to the lack of ICD-10-AM codes or their equivalents. Even for specialist alcohol and other drug treatment programs where minimum datasets include the primary drug of concern, the cost data associated with that care is not publicly available (in contrast to inpatient care where AR-DRG codes can be accessed).

Some cannabis-related medical conditions such as motor vehicle accidents, transport injuries and low birthweight were too generic for associated medications to be identified. Therefore, it was not possible to attribute pharmaceutical costs to these specific cannabis-attributed conditions. However, costs were estimated for medications used in treating chronic bronchitis, depression, schizophrenia and other psychoses. Thus, our estimate of cannabis-attributable medication costs will likely be an under-valuation.

Our estimate included a cost for high-level residential care and other aged-care services just in the high bound estimate. It is currently unclear to what extent these services will be used by the target population, where most will not be in the oldest age groups. From national data, in those aged 60 years and older, 2.9 percent reported use of cannabis in the previous year (Australian Institute of Health and Welfare, 2017e). However, it should be noted that as a “household” survey, those in residential care should not eligible. Nevertheless, there is growing interest in substance use in older populations as the baby-boomer generation ages (Han et al., 2009). Traumatic and other brain injuries may be prevalent in those with cannabis dependence, due to their elevated risk of traffic and other accidents (Barrio et al., 2012; Els et al., 2019; Rogeberg, 2019) and thus potentially disability requiring extensive care. Therefore, we have included a cost for this type of high-level care although the exact quantum is uncertain.

Care must be taken in comparing the costs of other health care between recent reports on methamphetamine, tobacco and extra-medical opioids, with slight variations in the methods used. For example, in estimating the costs of primary care for methamphetamine, costs were derived from a single survey in calculating “excess” GP service use (Whetton et al., 2016). In relation to tobacco and extra-medical opioids, a similar approach was taken to the method used here, except due to the greater availability of information on tobacco use, we were able to produce a narrower cost range (Whetton et al., 2019; Whetton et al., 2020). Overall, the estimates here more closely align with the methods used in the tobacco and extra-medical opioids reports than the methamphetamine report, where there was access to some unique research datasets.

CHAPTER 6: WORKPLACE COSTS

Alice McEntee, Ann Roche & Steve Whetton

6.1 Background

Cannabis is the illicit drug Australians aged 14 years or older have most commonly used in their lifetime (34.8% compared to 0.4%-11.2% for other illicit drug types) (National Centre for Education and Training on Addiction, 2019a). One in 10 Australians aged 14 years or older have used cannabis in the past 12 months, with prevalence higher for men (13% vs 8% for women), and those aged 18-24 years (23% vs 2%-20% for other age groups) (National Centre for Education and Training on Addiction, 2019b). Of these Australians who have used cannabis in the previous 12 months, most are employed (64.8%) compared with 11.0 percent and 24.2 percent of those who are unemployed or not in the labour force, respectively (National Centre for Education and Training on Addiction, 2019a). Prevalence of cannabis use varies by industry and occupational group. For example, the accommodation and food services (25%), arts and recreation (22%), and media and telecommunications (20%) industries have a much higher prevalence of cannabis use compared to other industries (National Centre for Education and Training on Addiction, 2019b). Among workers, the prevalence of cannabis use is also higher among males (14% vs 10% for females) and those aged 18-24 years (27% vs 4%-21% for other age groups) (National Centre for Education and Training on Addiction, 2019b).

Cannabis poses a workplace risk as use can impair short-term memory, cognition, balance and coordination, concentration, sensory perception, ability to perform complex tasks, and alertness and reaction time (Australian Safety and Compensation Council, 2007). Such effects can last between two and six hours after use and consequently can potentially negatively affect workplace safety, performance and productivity if use has occurred shortly before, or during, work hours. Approximately 2 percent of working Australians who used cannabis at least once in the past year reported using cannabis at their workplace (National Centre for Education and Training on Addiction, 2019a). Although cannabis use by employees can present a potential danger at work (Australian Safety and Compensation Council, 2007) there is a paucity of research concerning associated workplace safety and productivity costs.

A large-scale study in 2011 (Li et al.) examined post-accident workplace drug tests in over one million US workers between 1995 and 2005. Illicit drugs were detected in 1.2 percent of results, with cannabis detected in 67 percent of positive tests. A study in Iowa, USA (Ramirez et al., 2013) investigating occupational fatalities between 2005-2009, reported cannabinoids were detected in 19 out of 280 (6.8%) deaths (31.1% of all positive toxicology tests).

Research also indicates that cannabis use may impact Australian workplaces. Between 2001 and 2006, cannabis (Δ^9-THC) was detected in 3.8 percent of Victorian work-related fatalities (10 of the 12 (out of 318) deaths where toxicology testing was performed had a toxicology result of ≥5 ng/ml). Positive drug test results do not indicate impairment at the time of death. However, the coroner reported cannabis as a contributing cause of death (COD) in six of the 12 cases where cannabis was detected (McNeilly et al., 2010).

In Australia, cannabis use was responsible for 0.1 percent of the total burden of disease and injuries in 2011, equivalent to 5,373 disability-adjusted life years (DALY) in males (0.2% of the total burden for males) and 1,358 in females (0.1% of the total burden for females). Of the total burden of disease and injuries in 2011 attributed to cannabis, accidental poisoning accounted for 41.0 percent, cannabis dependence 35.6 percent, schizophrenia 8.2 percent, anxiety disorders 4.7 percent, depressive disorders 4.5 percent and road traffic injuries (motor vehicle occupants and motorcyclists) 6.0 percent (Australian Institute of Health and Welfare, 2018). In 2015, the burden of disease and injury attributed to cannabis use increased to 0.2 percent (10,585 DALY) (Australian Institute of Health and Welfare, 2019b).

To-date, estimates of drug-related absenteeism in Australian workplaces have largely been limited to alcohol and illicit drugs (undifferentiated by specific illicit drug type) (Pidd et al., 2006; Roche et al., 2008; Roche et al., 2015). The financial impost on workplaces of workers' use of illicit drugs was estimated by Roche et al. (2015) to cost $1,049.6 million in absenteeism specifically attributed to use of illicit drugs, and up to a further $228.7 million in illness- and injury-related absenteeism (over and above the absenteeism incurred by workers who did not use illicit drugs). An analysis of the impact of methamphetamine use in 2013/14 on workplace productivity and accidents estimated a cost of $289.4 million (Whetton et al., 2016). This estimate excluded work-related traffic accidents and deaths that were costed elsewhere.

Given that cannabis is the illicit drug most commonly used in Australia, it is imperative that all costs specifically attributable to employees' cannabis use and its associated impact on illness, injury and drug-related absences are quantified.

6.2 Methodology

National data were sourced to estimate cannabis-attributable costs to workplace-specific occupational injury (Section 6.2.1) and absenteeism (Section 6.2.2). Additional workplace costs due to cannabis use, where national data were not available, are discussed in Section 6.5.

6.2.1 Occupational injury

To establish the cost of occupational injuries, data were sourced from Safe Work Australia. The best available data [16] come from 2012/13 where injury data were reported for different severity levels and for claims which were compensable and non-compensable and that required absence for at least part of a workday.

Safe Work Australia (2015) reported the overall extent and cost of occupational injuries in 2012/13. The method used to determine the number of injuries was based on an incidence approach, rather than a prevalence approach (see Appendix 6.1 for further detail of Safe Work Australia's incidence approach). The method used to determine the costs incurred from injuries was based on the concept of the 'human cost' of occupational injury. Only costs associated with actual injuries were included (see Appendix 6.2 for the type of costs included).

Due to an overlap in the reporting of Safe Work occupational injuries with other sections of this report (e.g. Chapter 3 includes workplace costs of premature mortality, and Chapter 8 reports on transport accidents) the number of occupational injuries and associated costs were adjusted to prevent double counting. The adjustments involved: 1) removing the cost of fatalities from the total costs; and, 2) reducing all injury severity type costs by 3.9 percent. The latter adjustment was based on traffic accidents having

[16] National data for serious compensable injuries (≥5 days off work) are collated annually. Published data which also includes lower severity level injuries and non-compensable injuries were last collected in 2012/13. Thus, 2012/13 data are used in the present report.

accounted for 3.9 percent of *serious* compensable occupational injuries (≥5 days off work) in 2012/13 (Safe Work Australia, 2014). It was assumed that a similar proportion of traffic accidents occurred for injuries involving a short absence, long absence, partial incapacity or full incapacity.

The cost of non-fatal and non-transport accident occupational injuries attributed specifically to cannabis use was then identified. To determine this, the RR of an occupational injury being incurred by workers affected by cannabis use and the prevalence of workers affected by cannabis were estimated.

The RR estimate for cannabis was determined using findings from Li et al. (2011b) and Grant (2014). In Li et al.'s (2011b) case control study of more than one million post-accident workplace drug tests, an OR of 3.4 for an occupational injury among employees who tested positive for drug use was reported. To calculate the AF for cannabis, this OR was converted to a RR. Grant (2014) provided the formula for the conversion as follows:

$$RR = \frac{OR}{1 - p_0 + (p_0 * OR)}$$

Where:

RR = relative risk for the risk factor in question;
OR = odds ratio for the risk factor in question; and,
p_0 = the baseline risk

Applying this formula to the OR from Li and colleagues (2011b) and using a baseline risk of 0.032480486 (based on 374,500 occupational injuries (Safe Work Australia, 2015) among a total workforce 11,530,000 in 2012/13) gives a RR of 3.154.

Data collected by Safework Laboratories indicated an Australian workplace drug testing positivity rate of 1.7 percent for cannabis, 2.9 percent for opioids, 1.6 percent for amphetamine type stimulants (ATS), and 0.8 percent for benzodiazepines from a sample of 98,599 random workplace drug tests conducted in 2015 (A. Leibie, Safework Laboratories Australia, personal communication, 17th May 2016) [17].

Applying the RR calculation gives an aetiological fraction (AF) of 0.132654387 for all drugs detected and an AF of 0.03532648 for cannabis. The AF for cannabis was then used to determine the cannabis-attributable cost of non-fatal and non-transport accident occupational injuries.

6.2.2 Workplace absenteeism

To estimate the extent and cost of cannabis-related workplace absenteeism, secondary analyses were conducted on 2016 NDSHS data (Australian Institute of Health and Welfare, 2017i). Only respondents who were employed and aged ≥ 14 years were included in the analyses.

An illicit drug use status variable comprising three categories was created. The three categories were: 1) cannabis use; 2) other drug use [18]; and, 3) no drug use.

---

[17] National data concerning workplace testing are unavailable prior to 2015 (A. Leibie, Safework Laboratories Australia, personal communication, 17th May 2016).
[18] Data from this group are not reported in the associated results tables.

In relation to absenteeism, two variables were used: absence due to injury and/or illness; and, absence due to their drug use. Annual absenteeism due to injury and illness involved summing the total number of days absent from work, school, university or TAFE due to injury or illness in the past three months and then multiplying these days by four to obtain a non-seasonally adjusted annual estimate (with a maximum 240 days absent possible). Annual absenteeism due to drug use was also determined by multiplying by four the number of days absent from work, school, university or TAFE due to their own drug use in the past three months (with a possible maximum of 240 days absent).

Analysis of Variance (ANOVA) tests were conducted to establish whether cannabis use resulted in more days absent from work due to: a) illness/injury; and, b) drug use, compared to those who:

- used other types of illicit drugs; and,
- did not use drugs (this comparison group was only included in the analysis examining days off due to illness/injury, as it was not applicable for the drug use analysis).

Two Analysis of Covariance (ANCOVA) tests were then conducted to determine the means for: a) illness and injury absenteeism; and, b) drug-related absenteeism by illicit drug use status while controlling for age, gender, marital status, socio-economic status, and occupation. These variables were controlled for as they are known to be associated with workplace absence (Bush and Wooden, 1995; Ekpu and Brown, 2015).

Total absenteeism-related costs for each illicit drug use status category were then estimated. To accomplish this, the difference in the mean number of annual days absent according to illicit drug use status was calculated by subtracting the mean days absent among the group who did not use drugs from each of the other two categories. This figure was then multiplied by $373.66 [19] (one day's wage plus 20% employer on-costs, based on the average weekly income in 2015 [20]) (Australian Bureau of Statistics, 2016a, c) to obtain a cost estimate of cannabis-related absenteeism (i.e. following a replacement labour cost approach, rather than an economic output per day worked approach).

6.3 Costs due to occupational injury

The results presented below first provide an overview of the number and costs of occupational injuries due to all causes (Section 6.3.1), followed by the costs of non-fatal and non-transport occupational all cause injuries borne by employers, employees, and the community. The 2015 CPI (Australian Bureau of Statistics, 2016c) calculator was then applied to the 2012/13 estimates of all cause occupational injury costs. The latter results were then used to estimate the cost of occupational injuries (non-fatal and non-transport accidents) attributable to cannabis using the RR and AF calculations (Section 6.3.2).

6.3.1 Number and costs of injuries

In 2012/13 there were 374,500 occupational injuries (Safe Work Australia, 2015). A breakdown by injury severity and compensation status is presented in Table 6.1.

---

[19] Whetton et al. (2016) included an identical method to determine absenteeism costs attributed to methamphetamine with the exception of the daily wage calculation. The present report determined daily wage using the full-time adult total weekly wage earnings (seasonally adjusted data) for November 2015. The daily wage calculation for the cost of methamphetamine was based on the person's total weekly wage earnings (trend data) for November 2013. Both values were divided by five to determine daily wage and then 20% employer on-costs were added. Appendix 6.3 provides estimated costs of absenteeism attributed to cannabis using the November 2015 person's total weekly earnings trend data.

[20] Average weekly income data for 2015 was selected in order to maintain consistency across other chapters of this report.

Table 6.1: Compensable and non-compensable occupational injuries by severity 2012/13

Injury		Short absence [a]	Long absence [b]	Partial incapacity [c]	Full incapacity [d]	Fatality	All
Compensated	%	59	34	7	<1	<1	100
	N	122,500	71,500	14,200	400	197	208,800
Not compensated	%	65	29	6	<1	<1	100
	N	107,200	48,400	9,600	300	203	165,700
All	**%**	**61**	**32**	**6**	**<1**	**<1**	**100**
	N	**229,700**	**119,900**	**23,800**	**700**	**400**	**374,500**

Source: Safe Work Australia, 2015. The Cost of Work-related Injury and Illness for Australian Employers, Workers and the Community: 2012–13. Canberra, Safe Work Australia.
a < 5 days off work.
b ≥5 days off work and return to work on full duties.
c ≥5 days off work and return to work on reduced duties or lower income.
d Permanently incapacitated with no return to work.

The compensable and non-compensable occupational injuries for 2012/13 (Safe Work Australia, 2015) resulted in a total estimated cost of $28.2 billion (Table 6.2). After excluding fatalities and transport accidents (i.e., costs accounted for in Chapters 3 and 8, respectively), the adjusted cost was $26.3 billion (Table 6.2).

Table 6.2: Costs ($000,000) of occupational injuries by severity 2012/13 [a]

Cost	Short absence [b]	Long absence [c]	Partial incapacity [d]	Full incapacity [e]	Fatality	Total
Unadjusted cost ($000,000)	960	4,340	19,250	2,800	880	28,230
Adjusted cost ($000,000) [f g]	923	4,171	18,499	2,691	-	26,284

Sources: Safe Work Australia, 2014. Australian Workers' Compensation Statistics 2012–13. Canberra, Safe Work Australia. Safe Work Australia, 2015. The Cost of Work-related Injury and Illness for Australian Employers, Workers and the Community: 2012–13. Canberra, Safe Work Australia.
[a] Costs were rounded to the nearest $1 million in the Safe Work Australia (2014) report.
[b] < 5 days off work.
[c] ≥5 days off work and return to work on full duties.
[d] ≥5 days off work and return to work on reduced duties or lower income.
[e] Permanently incapacitated with no return to work.
[f] Fatalities and transport accidents were excluded as they are reported in Chapter 3 and Chapter 8, respectively.
[g] Safe Work Australia (2014) reported that traffic accidents accounted for 3.9% of serious compensable occupational injuries (≥5 days off work) in 2012/13. It was assumed that a similar proportion of traffic accidents occurred for injuries requiring a short absence, long absence, partial incapacity and full incapacity and thus such associated costs were reduced by 3.9%.

Safe Work Australia (2015) estimates of the proportions of occupational injury costs borne by employers, employees, and the community were then used to calculate apportioned costs for non-fatal and non-transport occupational injuries (Table 6.3).

6.3.2 Costs of injuries due to cannabis use

Updating the 2012/13 all cause costs to 2015/16 [21] by applying the CPI (3%) (Australian Bureau of Statistics, 2016c) gives a total cost of $27.2 billion. Applying the AF for cannabis (0.03532648), the total attributable cost of cannabis use associated with non-fatal and non-transport occupational injuries in 2015/16 was **$960.4 million** with **$57.6 million** borne by employers, **$240.1 million** by the community,

[21] The December 2015 quarterly Consumer Price Index calculator was used to adjust the 2012/13 data to align with timeframes used in other sections of this report.

and **$662.7 million** by injured employees (Table 6.3). Costs borne by employees are internal costs and thus not included in the total estimate for workplace costs attributable to cannabis. The total estimate for occupational injury costs attributed to cannabis is **$297.7 million** (see Table 6.8).

Given the nature of the available data, it is not possible to identify the extent to which the workplace injuries occurred to the person who used the drug, or to someone else. As such it is possible that these estimates include some private costs to people who used the drug.

Table 6.3: Costs of non-fatal and non-transport occupational injuries borne by employers, employees, and the wider community 2012/13 and 2015/16

Borne by	Cost (%)	Total Cost ($000,000) [c]		
		All cause 2012/13	All cause 2015/16[a]	Cannabis 2015/16 [b]
Employers	6	1,577	1,631.2	57.6
Employees	69	18,136	18,759.0	662.7
Community	25	6,571	6,796.7	240.1
Total	100	26,284	27,186.9	960.4

[a] Adjusted using the ABS Consumer Price Index inflation calculator to December 2015 values (Australian Bureau of Statistics, 2016c).
[b] The adjusted 2015/16 all cause occupational injury cost data were multiplied by the aetiological fraction (AF) for cannabis use (0.03532648) to determine costs borne by employers, employees and the community.
[c] Costs were rounded to the nearest $1 million in the Safe Work Australia (2014) report.

6.4 Costs due to workplace absenteeism

A total of 11,705 (weighted N = 10,363,237) employed Australians aged 14 years or older provided past year illicit drug use information in the 2016 NDSHS. Of these, 12.3 percent used cannabis, 5.3 percent used drugs other than cannabis, and 82.4 percent did not use drugs in the past year.

Results of the ANOVA indicated that there was a statistically significant association between the three drug use groups regarding workplace absenteeism due to illness or injury ($F [2, 10444] = 9.135, p < .001$). On closer inspection, workers who used cannabis were significantly more likely to be absent from work than those who did not use drugs ($p < .001$) (Table 6.4).

Table 6.4: The unadjusted excess workplace absenteeism due to illness/injury among those who used cannabis, and those who did not use drugs (2016 NDSHS data [a]) [b]

Drug use status	Annual Illness or Injury Absence		
	Mean Days Absent (95% CI)	Difference [c] (95% CI)	p-value [d]
No drug use	7.754 (7.244 – 8.264)		
Cannabis use	10.749 (9.299 – 12.200)	2.995 (2.055 – 3.936)	< .001

[a] Australian Institute of Health and Welfare, 2017. National Drug Strategy Household Survey (NDSHS) 2016, Drug Statistics Series. Canberra, Government of Australia.
[b] ANOVA results related to other drugs are not reported.
[c] Mean days absent due to illness/injury for cannabis use minus mean days absent for no drug use.
[d] Significance of mean difference in days absent due to cannabis use compared to no drug use.

Results of the ANCOVA indicated that, after controlling for age, gender, marital status, socio-economic status, and occupation (Bush and Wooden, 1995), there was a significant association between the three drug use groups regarding absenteeism due to injury or illness ($F [2, 6980] = 7.592, p = .001$). Marital status was found to be a significant covariate ($F = 7.111, p = .008$). Workers who used cannabis were absent due to injury and illness an extra 4.5 million days from work per year compared to workers who did not use drugs, equating to a cost of approximately $1.7 billion (Table 6.5).

Cannabis is often used concurrently with tobacco (67% of the cannabis users in employment were also current or former smokers) and the costs associated with tobacco have been accounted for elsewhere (Whetton et al., 2019). To prevent double counting, the costs of cannabis use associated with injury/illness absences was adjusted to exclude the excess days of absence due to tobacco, giving an adjusted total of $769.7 million (low bound $577.8 million, high bound $961.3 million) (Table 6.5).

Table 6.5: The adjusted excess workplace absenteeism due to illness/injury for those who used cannabis, and those who did not use drugs (2016 NDSHS data [a]) and associated costs (2015 ABS data [b]) [c d]

		Annual Illness or Injury Absence			
Drug use status	**Estimated Population**	**Mean Days Absent (95% CI)**	**Difference [e] (95% CI)**	**Excess Days Absent [f] (95% CI)**	**Cost $ [g] (95% CI)**
No drugs	8,536,278	7.556 (6.908 – 8.203)			
Cannabis	1,275,639	11.077 (9.443 – 12.710)	3.521 (2.535 – 4.507)	4,491,577 (3,234,312 – 5,748,843)	1,678,322,744 (1,208,533,166 – 2,148,112,748)
Cannabis (excluding tobacco [h])	419,303	12.468 (10.596 – 14.338)	4.912 (3.688 – 6.135)	2,059,795 (1,546,294 – 2,572,596)	769,662,934 (577,788,132- 961,276,275)

[a] Australian Institute of Health and Welfare, 2017. National Drug Strategy Household Survey (NDSHS) 2016, Drug Statistics Series. Canberra, Government of Australia.
[b] Australian Bureau of Statistics (ABS), 2016. Average Weekly Earnings, Australia, Nov 2015. Cat. no. 6302.0. Canberra, ABS.
[c] Calculations based on estimated absenteeism means adjusted for age, gender, marital status, socio-economic status, and occupation.
[d] ANCOVA results related to other drugs are not reported.
[e] Mean days absent due to illness/injury for cannabis use minus mean days absent for no drug use.
[f] Difference in mean absence multiplied by estimated population.
[g] Excess absence multiplied by $373.66 (2015 average daily wage plus 20% employer on-costs).
[h] Excludes those who are daily, occasional, and ex-smokers as the costs associated with tobacco use (including concurrent use of cannabis) are accounted for in Whetton et al. (2019). This group was not included in the ANCOVA analysis.

Workers who used cannabis, however, may also use other drugs and it may be the other drugs which account for the worker's absenteeism. Poly-substance use (excluding alcohol and tobacco) occurred in three out of 10 people who used cannabis (National Centre for Education and Training on Addiction, 2019a). Table 6.7 details the proportion of workers who used other drugs in the same 12-month period in which cannabis was also used.

Of those who used illicit drugs, cannabis use did not significantly predict workplace self-reported drug-related absenteeism more than for those who used other drugs ($F [1, 1818] = 1.002$, $p = .317$).

As shown in Table 6.6, after controlling for known confounders (Bush and Wooden, 1995) use of cannabis was associated with 341,282 excess days off work due to drug use per year. This equated to an annual cost of approximately $127.5 million.

Table 6.6: Adjusted excess workplace absenteeism due to drug use attributable to cannabis (2016 NDSHS data [a]) and associated costs (2015 ABS data [b]) [c d]

Drug use status	Estimated Population	Annual Absence due to drug use		
		Mean Days Absent (95% CI)	Excess Days Absent (95% CI) [e]	Cost $ (95% CI) [f]
Cannabis	1,275,639	0.268 (0.029 – 0.506)	341,282 (37,577 – 644,987)	127,523,397 (14,041,104 – 241,005,747)

[a] Australian Institute of Health and Welfare, 2017. National Drug Strategy Household Survey (NDSHS) 2016, Drug Statistics Series. Canberra, Government of Australia.
[b] Australian Bureau of Statistics (ABS), 2016. Average Weekly Earnings, Australia, Nov 2015. Cat. no. 6302.0. Canberra, ABS.
[c] Calculations based on estimated absenteeism means adjusted for age, gender, marital status, socio-economic status, and occupation.
[d] ANCOVA results related to other drugs are not reported.
[e] Days in excess of those who do not use drugs. Mean days absent multiplied by estimated population.
[f] Excess absence multiplied by $373.66 (2015 average daily wage plus 20% employer on-costs).

Table 6.7: Proportion of workers using other drugs in addition to cannabis in the past 12 months by drug type used [a]

Drug Type	%	Drug Type	%	Drug Type	%
Ecstasy	20.1	Ketamine	3.3	Methadone	0.4
Hallucinogens	12.1	Tranquillisers	2.5	Steroids	0.3
Cocaine	11.3	Heroin	1.3	Inhalants	0.1
Methamphetamine	9.7	GBH	0.9	Other	0.3
Painkillers	7.7	Kava	0.9		

Source: Australian Institute of Health and Welfare, 2017. National Drug Strategy Household Survey.
[a] Used cannabis at least once in the past 12 months.

In order to account for poly-substance use (Table 6.7), the estimated cannabis-related absenteeism reported in Table 6.5 and Table 6.6 was divided by 1.709 (i.e. the summed proportion of those who used cannabis and other drugs). This resulted in an annual cost of excess absenteeism due to illness and injury attributable to cannabis use of **$450.4 million** [22], and an estimated cost of absenteeism due to drug use attributable to cannabis of **$74.6 million** [23]**.** The cost attributable to *drug use* related absenteeism (**$74.6 million)** is likely to be a conservative estimate as it was obtained from a self-report measure of absenteeism that respondents attributed to drug use and was used as our low bound estimate for absenteeism (Table 6.8). The cost attributed to *injury and illness* absenteeism **($450.4 million)** however is likely to be an overestimate as higher proportions of those who use cannabis also drink alcohol at risky levels, compared to the general working population (National Centre for Education and Training on Addiction, 2019a). Alcohol use has substantial negative impacts on physical health and is unaccounted for in the estimates presented here. The cost attributed to injury and illness absenteeism was used as the high bound estimate, with the mid-point (**$262.5 million**) used as the central estimate (Table 6.8) [24].

[22] The cost of cannabis use attributed to illness/injury absenteeism ($769,662,934) divided by 1.709.
[23] The cost of cannabis use attributed to drug-related absenteeism ($127,523,397) divided by 1.709.
[24] Refer to Appendix 6.4 for the total costs attributed to cannabis use unadjusted for tobacco use.

Table 6.8: Summary: Workplace costs due to cannabis use

Cost area	Central estimate $	Low bound $	High bound $
Occupational injury [a]	297,720,000	297,720,000 [b]	297,720,000 [b]
Absenteeism	262,488,687	74,618,723	450,358,651
Total	**560,208,678**	**372,338,723**	**748,078,651**

[a] Cost to employer ($57,620,000) plus cost to community ($240,100,000). Employee costs are an internal cost and thus not included in the total cost estimate for occupation injury (see Table 6.3).
[b] The low/high bound estimate duplicates the central estimate.
[c] The mid-point of the low and high bound estimates.

The attributable costs of cannabis use to workplace absenteeism reported in Tables 6.5 and 6.6 reflect likely workplace costs directly associated with paid sick leave only. There are also likely to be other indirect costs, such as the cost of finding and paying replacement workers to backfill the absent employee's work role and/or the cost of lost productivity if a replacement worker cannot be sourced.

6.5 Conclusions

The total cost of cannabis to Australian workplaces is estimated to be **$560.2 million** (Table 6.8). As data were only available to determine workplace costs associated with occupational injury and absenteeism, it is likely that the true cost of cannabis to the workplace is higher. There are additional costs that cannot currently be quantified. These are discussed below.

6.5.1 Other workplace costs

Additional workplace costs associated with cannabis use that cannot be quantified due to lack of data include the following:

Presenteeism can be defined as attending work while unwell or impaired, resulting in reduced quality or quantity of work. As cannabis use can result in poor physical and mental health, tiredness, poor concentration, and poor work performance, it is likely that cannabis use contributes to presenteeism. However, there are no currently available data concerning presenteeism in Australian workplaces.

Turnover costs are incurred when employees who leave (either voluntarily or involuntarily) are replaced. Costs are associated with hiring, training, reduced productivity, and lost opportunity. Cannabis use is likely to contribute to these costs if an employee: a) is dismissed for failing a workplace drug test; b) leaves because their use has escalated to severe dependence and restricted their ability to work effectively; or, c) is dismissed due to drug-related poor performance. However, there are no current reliable data concerning the costs to Australian workplaces due to drug-related turnover.

Workplace drug testing is becoming more common in Australian workplaces. The costs incurred in implementing workplace testing include: a) the purchase of testing services; b) lost productivity while employees undergo testing; and, c) legal and industrial relations costs in the establishment of, and possible defence of, workplace testing procedures. Cannabis use substantially contributes to these costs as cannabis is the most common illicit drug detected in workplace tests (Phillips et al., 2015). Across the Australian workforce, the total costs of workplace drug testing are likely to be substantial. Nearly 7 percent of the Australian workforce reports that their workplace conducts drug tests (Pidd et al., 2015) with one of the larger workplace drug testing service providers undertaking nearly 100,000 tests across Australia in 2015 (A. Leibie, Safework Laboratories Australia, personal communication, 17th May 2016). However, accurate data concerning the extent and costs of workplace drug testing across the Australian workforce are not currently available.

Employee wellbeing costs are incurred when employee's mental and physical health is affected by the behaviour of co-workers and traumatic workplace incidents. Employed people who use cannabis are more likely to have higher levels of psychological distress (17.5%) compared to employees who do not use cannabis (8.9%) (National Centre for Education and Training on Addiction, 2019a). Thus, cannabis use may contribute to employees seeking counselling and/or utilising Employee Assistance Programs. Additional costs may also be incurred through impacts on employee safety and productivity due to poor worker wellbeing.

The cost to workplaces attributed to cannabis use are likely to be unevenly distributed across Australian workplaces. Prevalence of cannabis use varies substantially across different occupational and industry groups (National Centre for Education and Training on Addiction, 2019b). For example, cannabis use varied from 6 percent [25] in the mining industry to 25 percent in the accommodation and food services industry (National Centre for Education and Training on Addiction, 2019b). Workplace costs are likely to be higher in industries with a higher prevalence of cannabis use. As noted earlier, the prevalence of recent cannabis use is also higher among employed males (14% vs 10% for females) and those aged 18-24 years (27% vs 4%-21% for other age groups) (National Centre for Education and Training on Addiction, 2019b). As participation in vocational training is high in young employed males, cannabis use may also contribute to training attrition costs.

6.5.2 Limitations

6.5.2.1 Accidents

Cannabis use can impair coordination, distort perception, affect thinking and memory, decrease reaction time and lead to anxiety, panic and paranoia (Australian Safety and Compensation Council, 2007). The impacts of this on road crashes and workplace accidents are explored in Chapter 8 and Section 6.3.1, respectively, however there is also the potential for excess rates of other forms of accidental injury such as vehicle crashes that do not occur on the road, falls, burns and scalds, drowning, and sharp object injuries. At present, whilst case studies have identified a role for cannabis in increasing risk (Khashaba et al., 2017; Wadsworth et al., 2006), there are no reliable estimates of the extent to which cannabis contributes to excess rates of these forms of injury in Australian workplaces. As such they were not included in our calculations.

6.5.2.2 Occupational injuries

Data concerning occupational injuries is limited. At present, annual data are reported only for serious (resulting in ≥5 days off) compensable injuries. Data concerning less serious compensable and non-compensable injuries are reported less frequently. Such data are not reported on by drug-type and thus costs attributed to cannabis use were estimated by applying formulas considered reliable. Data of this type are limited and could only be sourced from one large national workplace testing service provider (Safework Laboratories). Due to such limitations, the true cost of occupational injuries attributable to the use of cannabis may not be accurately reflected.

[25] Estimate has a relative standard error greater than 50% and is considered too unreliable for general use.

6.5.2.3 Absenteeism

Estimates of cannabis-related workplace absenteeism were obtained from a self-report measure. Self-report data may not accurately reflect true absenteeism attributed to illness or injury, and drug use. Furthermore, a proportion of the absenteeism costs calculated may have already been accounted for in the cannabis occupational injury estimates if the survey respondent is reporting absenteeism due to an occupational injury.

Absenteeism cost estimates were based on the assumption that people annually worked 5 days a week over 48 weeks, with 4 weeks annual leave. This may inadequately reflect the work schedule of employees who work part time, overtime, or longer rosters, and limits assumptions about annual absenteeism rates.

6.5.2.4 Reduced participation in the workforce

Evidence suggests that regular cannabis use, and particularly dependent use, is correlated with reduced participation in the workforce (Fergusson and Boden, 2008). No Australian research has quantified the extent of the impact on employment in terms of its scale, or direction of causation. Direction of causation may be important, as it is unclear whether cannabis use impacts workforce participation or whether reduced workforce participation impacts cannabis use. As such, these costs cannot currently be quantified.

Acknowledgements

We thank Mr Andrew Leibie, National Marketing Manager of Safework Laboratories, for providing access to national workplace drug testing data.

CHAPTER 7: CRIMINAL JUSTICE SYSTEM

Neil Donnelly & Steve Whetton

7.1 Background

While studies conducted in the USA, UK, Canada and Australia have shown a strong association between illicit drug use and levels of different types of crime, the causal pathway of this relationship has not been resolved. In a meta-analysis of 30 studies, Bennett et al. (2008) found that while offending was higher among those who use drugs compared with those who do not use drugs, the strength of the relationship varied by drug type. While offending was higher among people who had used cannabis it was not as high as it was among those who had used crack (cocaine), heroin or (powder) cocaine. The causal issue is complex as it appears to not be a simple question of whether initiation of drug use then leads to involvement in crime or vice versa, or indeed whether they are both jointly caused by some other factor such as propensity for risk taking or social alienation.

While understanding the causal issue between cannabis use and crime requires more research to be conducted, the opportunity remains to investigate the cost of crime related to cannabis use. There are obvious direct costs of enforcement of drug laws which can be included in social cost studies (Caulkins, 2010; Marks, 1994). However, a number of studies expand the scope of included crime to property and interpersonal crime attributable to substance use. A study conducted in Canada compared the costs of alcohol, opioids and cannabis across four categories including criminal justice (Canadian Substance Use Costs and Harms Scientific Working Group, 2018). Indeed, costs of crime beyond the costs of drug law enforcement is a commonly included source of cost in social cost studies with a number of recent examples including broader crime costs in social costs of cannabis (Collins and Lapsley, 2008; Fernández, 2012; Pacula, 2010; Rehm et al., 2006; Roper and Thompson, 2006).

In Australia, a recent report by Whetton et al. (2016) estimated of the costs of methamphetamine use to the criminal justice system in 2013/14. A further report estimated the costs of heroin [26] use to the criminal justice system in 2015/16 (Whetton et al., 2020). The current investigation applies a similar methodology to examine the costs of crime related to cannabis use in Australia in 2015/16.

Criminal justice system data are not generally suited to statistical analyses relating to drug use, as information such as cannabis use, and its alleged role in the offence, is not routinely recorded. If recorded at all, the information is often located in narrative and is not available for analysis without first going through each file individually and coding the relevant data. Instead, analysis of the role of substance use in crime in Australia usually employs the DUMA survey as this is the only regular survey of police detainees and substance use in Australia (Patterson et al., 2018). The DUMA survey has several shortcomings; most notably that it only surveys offenders from selected police stations, which may not be representative of the population of offenders for the country as a whole [27]. Given the lack of data on the geographic distribution of regular cannabis use, it is not possible to identify whether the rates of cannabis consumption amongst offenders detained by police at the selected DUMA sites are representative of the country as a whole, or under or overestimates it.

[26] Note: the report assessed the costs of extra-medical opioid use in other chapters, but only heroin in the chapter on crime.
[27] For the 2015/16 survey, data were collected in the following police stations: Brisbane (Queensland); Bankstown and Surry Hills (New South Wales); Adelaide (South Australia); and Perth (Western Australia) (Patterson et al., 2018).

Other limitations of the DUMA survey are that:

- It can only provide data on those police detainees who were in police custody at the time of the survey (which may over-represent those alleged to have committed more serious offences) and who consent to participate in the research. The long-term participation rate was 87 percent; in 2015/16 it was 60 percent overall but was 82 percent if restricted to those detainees deemed eligible to participate (Patterson et al., 2018);
- Attribution to substance use is based on self-assessment by the detainee. It is not known whether there are any systematic biases in the propensity of offenders to attribute their offending to their use of a substance. These biases could include: falsely attributing offending to a substance as a self-exculpatory strategy; failing to attribute offending to the substance use that caused it, either through underestimating the extent the substance distorted their reasoning, or through a concern of being stigmatised for offending under the influence of the substance;
- Detainees are automatically excluded from the sample frame if they are observed to be intoxicated at the time the researcher attends the station. This may lead the survey to understate the role of substances in offending as those who were intoxicated at the time of the offence are more likely to be excluded than those who were not;
- It is only appropriate as a source of data on the involvement of substances in the offending behaviour of adults, with the sample of juveniles captured in the survey being too small to derive usable AF. This will tend to understate the impact of substances on crime as at least some juvenile offending is likely to be attributable to substance use, and;
- The AF for substances calculated from it only relate to crime committed by those who have used the substance in the last 30 days. This means it will not capture that proportion of "systemic" crime where the perpetrators are not, themselves, people who have recently used the substance in question.

As with concerns over the representativeness of the sites selected for the survey, it is not possible to determine whether the known limitations of the survey will lead to it over- or underestimating the role of substance use in offending. Notwithstanding these limitations, the DUMA survey remains the best available source of data on drug use of offenders in Australia.

For this project, analysis of the DUMA data for the 2015/16 financial year was undertaken by the Australian Institute of Criminology (AIC) to identify the proportion of police detainees who attributed their offending to different illicit substances. This methodology uses the responses to several survey questions to determine the proportion of detainees who attribute their current offending (i.e. offences for which individuals were detained at time of the interview), either entirely or partly, to drug use during the past 30 days (Payne and Gaffney, 2012). The detainees were asked to consider the main reason why they had been detained and to indicate via a three-point scale the extent their drug use contributed to their present situation. The questions were asked separately for each different drug type so that attributions could be assigned by drug type. Attributions by offence type were estimated by assigning detainees to a most serious offence (MSO) category on the basis of the charges recorded against them for their current detention. The MSO hierarchy included violence, property, illicit drug, traffic or driving under the influence (DUI), breach, public order and other.

Table 7.1 provides the cannabis AF percentages broken down by the MSO category of adult detainees. In total, 8.0 percent of adult detainees attributed their offending to cannabis. The highest AF percentages were found for detainees whose MSO was illicit drug (12.8%), property (10.1%), violent (7.6%), breach (7.4%) and public order (6.7%).

The subsequent sections of this Chapter will focus on: (i) police costs; (ii) court costs; (iii) correction system costs; and, (iv) costs to victims of crime. In each section national data reported by the ABS will be used and the AF percentages shown in Table 7.1 will be applied to the relevant offence categories. This will include the central estimate cost and also a low bound cost and a high bound cost based on the 95% CI shown in Table 7.1.

Table 7.1: Self-reported cannabis-attribution of crime amongst police detainees by most serious offence, DUMA survey July 2015 to June 2016, percent of total offenders

Attributable fraction	Violent	Property	Illicit drug	Traffic or DUI	Breach	Public order	Other	Total
Central estimate (%)	7.6	10.1	12.8	1.7	7.4	6.7	3.2	8.0
95% CI	5.8, 9.8	7.5, 13.4	8.9, 18.1	0.5, 5.9	5.5, 9.8	3.5, 12.2	0.6, 16.2	7.0, 9.3
Sample size (n)	699	397	203	119	570	135	31	2154

Source: Australian Institute of Criminology Drug Use Monitoring Australia collection 2015-16 [computer file]; confidence intervals calculated by authors using Wilson estimator.
DUI = driving under the influence.

Table 7.2: Mapping of principal offence in Australian Bureau of Statistics data to DUMA most serious offence by ANZSOC Divisions

Most serious offence in DUMA	ANZSOC Principal Offence (Divisions)
Violent	01 Homicide and related offences 02 Acts intended to cause injury 03 Sexual assault and related offences 04 Dangerous/negligent acts 05 Abduction/harassment 06 Robbery/extortion 11 Prohibited/regulated weapons
Property	07 Unlawful entry with intent 08 Theft 09 Fraud/deception
Illicit drug	10 Illicit drug offences
Traffic or DUI	14 Traffic and vehicle regulatory
Breach	15 Offences against justice
Public order	12 Property damage and environmental pollution 13 Public order offences
Other	16 Miscellaneous offences

Sources: Australian Institute of Criminology Drug Use Monitoring Australia collection 2015-16 [computer file]; Patterson et al., (2018); ABS (2011).
ANZSOC = Australian and New Zealand Standard Offence Classification; DUI = driving under the influence.

The ABS defines most serious offence based on the 16 divisions of the Australian and New Zealand Standard Offence Classification (ANZSOC) (Australian Bureau of Statistics, 2011). Table 7.2 shows how the DUMA MSO categories shown in Table 7.1 relate to the ANZSOC divisions. For example, the number of '08 *Theft*' offenders reported by the ABS would be multiplied by the Property AF shown in Table 7.1 (10.1%) to provide the number of cannabis-related theft offenders. These would then be combined with the number of cannabis-related '07 *Unlawful enter with intent*' offenders and cannabis-related '09 *Fraud/deception*' offenders to provide the total number of cannabis-related 'Property' offenders.

7.2 Police costs

The real recurrent expenditure on state and territory police services in Australia was approximately $11.0 billion in 2015/16 (costs related to Australian Federal Police activities outside of general policing in the ACT have not been included in this section). However, only a subset of policing costs should be included in the analysis of cannabis-attributable crime, as police perform a range of functions unrelated to, or only partially related to, crime, such as protective services, emergency management, policing community events, managing compliance with liquor licensing regulations and traffic management.

Smith et al. (2014) reported that it is reasonable to allocate 80 percent of police costs to crime, based on 2011 data from NSW Police. An alternative estimate can be derived from a WA Police report (Western Australian Police, 2014), which allocated expenditure between activity types (with administrative costs allocated based on their share of operational expenditure). For the purposes of this calculation, "Intelligence and protective services"; "Response to, and investigation of, offences"; and, "Services to the Judicial Process" are assumed to be crime related activities, with "Crime Prevention and Public Disorder"; "Community Support (non-offence)"; "Emergency Management"; and, "Traffic Law Enforcement and Management" classed as non-crime activities, giving an estimate of 64 percent of police time being crime related. As this is a more conservative estimate, we have used the proportion of crime allocated to crime estimated from Western Australian Police data for this analysis.

Police costs to be used in estimating the costs of cannabis-attributable crime also need to be adjusted down as our AF are derived from data on adult offenders, and may not be applicable to offenders aged less than 18 years of age. Some 13 percent of offenders processed by police are aged 17 or younger (Australian Bureau of Statistics, 2014a), and we use this as an approximation of the share of police time spent on juvenile offenders, with 87 percent on adult offending. Applying these two proportions (64% and 87%) to overall police costs of $11.0 billion gives an estimate of $6.9 billion in police costs that can be attributed to the response to offences committed by adults. This is the base from which the cost of cannabis-related police time is calculated.

To allocate the costs of police time across different offence categories, we obtained data on the total number of offenders processed by police in 2015/16. This was sourced from the ABS publication "Recorded Crime – Offenders" (Australian Bureau of Statistics, 2017e). Unfortunately, this publication does not report the number of offenders processed for driving related offences, so for these offences the number of adult defendants processed in the courts in 2015/16 was used as a proxy (Australian Bureau of Statistics, 2017a). Simply allocating costs based on the number of offenders processed by police is likely to overestimate the amount of police time spent on frequent, but relatively straightforward, cases such as driving offences, and underestimate the time spent on cases that involve more intensive investigations, such as murder or major fraud. An approach that has been used previously (Moore, 2005) to weighting the raw numbers is to use data on the total police custody hours by offence category. It should be noted this relies on 2002 data (Taylor and Bareja, 2005). However, this also has the potential to be influenced by variations in the time taken to arrange bail or to be transferred to remand. Instead, we use court data on the average length of a trial in 2015/16 (Australian Bureau of Statistics, 2017a) as a reasonable proxy for the average complexity of cases by offence category and, therefore, for the cost of the police investigation.

Table 7.3 provides the cannabis-attributable police costs by MSO for adult offenders in 2015/16. The highest cannabis-attributable cost was found for violent offences ($159.3 million). The next highest cannabis-attributable costs were for property offences ($113.4 million) and drug offences ($112.2 million). Allocating police costs between offence categories on this basis, and then applying the AF for offences set out in Table 7.1 gives a central estimate of total cannabis-attributable police cost of **$474.8 million**, with a low bound of $326.4 million and a high bound of $930.3 million.

Table 7.3: Cannabis-attributable police costs by most serious offence, 2015/16

	Violent	Property	Drug	Traffic or DUI	Breach	Public Order	Not allocated	Total
Number of offenders	94,253	73,588	77,346	205,817	26,330	71,305	18,924	**567,563**
Weighting for relative complexity (from court data)	1.81	1.24	0.92	0.70	0.68	0.64	0.81	**1.00**
Estimated weighted share of police time on crime (%)	30.0	16.1	12.5	25.5	3.2	8.0	2.7	
Estimated value of police time on adult crime ($'million)	2,100.7	1,125.2	876.2	1,783.5	221.5	562.4	188.6	**6,858.1**
Central estimate of cannabis-attributable police costs ($'million)	159.3	113.4	112.2	30.0	16.3	37.5	6.1	**474.8**
Low bound of cannabis-attributable police ($'million)	122.7	84.2	77.9	8.2	12.2	19.9	1.1	**326.4**
High bound of cannabis-attributable police ($'million)	257.8	189.5	199.0	132.5	27.3	85.9	38.3	**930.3**

Source: ABS (2017a); Steering Committee for the Review of Government Service Provision, (2017b); Australian Institute of Criminology Drug Use Monitoring Australia collection 2015/16 [computer file]; calculations by the authors. Costs relating to juvenile offenders are excluded.
DUI = driving under the influence.

7.3 Court costs

Total recurrent expenditure on criminal courts in Australia was $853.5 million in 2015/16 (Steering Committee for the Review of Government Service Provision, 2017b). However, that includes Children's Court costs for which we do not have reliable AF for cannabis. Deducting Children's Court costs leaves $821.4 million in court costs that are in-scope. These court costs exclude the cost of operating such specialist courts as drug courts and do not include the cost of Federal courts (which process Commonwealth offences such as customs offences). Thus, with the exclusion of Children's Court and the Federal courts, the court costs are likely to understate costs attributable to cannabis.

Offender based AF calculated by the AIC from the DUMA survey in 2015/16 were used to assess the court costs attributable to cannabis. As with police costs, these court costs need to be allocated between offence categories (based on the alleged perpetrator's MSO) so that the relevant AF can be applied to them. This allocation was made on the basis of the proportion of total defendant weeks for that level of court.

Table 7.4 displays the findings from both Higher courts (Supreme and District courts) and Magistrates courts. Applying the relevant AF gives a central estimate of total court costs attributable to cannabis in 2015/16 of **$35.0 million** for Higher courts. The low bound of cannabis-related costs was $25.7 million and the high bound costs was $47.6 million. In Magistrates Courts applying the relevant AF gives a central estimate of total court costs attributable to cannabis in 2015/16 of **$27.2 million**. The low bound of cannabis-related costs in Magistrates courts was $18.6 million and the high bound costs was $43.4 million.

Combining Higher and Magistrates court costs the central estimate of total cannabis-attributable court costs in 2015/16 was **$62.2 million**. The low bound of total cannabis-related court costs was **$44.3 million** and the high bound was **$91.0 million** (see summary Table 7.18).

Table 7.4: Cannabis-attributable court costs by most serious offence and level of court, 2015/16

	Violence	Property	Drugs	Traffic or DUI	Breach	Disorder	Not allocated	Total
Higher Courts								
Number of defendants finalised	7,506	1,689	3,827	7	259	342	62	13,692
Total defendant weeks	335,788	71,789	158,821	188	11,215	14,434	3,212	595,445
Assumed court costs ($million)	214.0	45.7	101.2	0.1	7.1	9.2	2.0	379.4
Central estimate of cannabis-attributable court costs ($million)	16.2	4.6	13.0	0.0	0.5	0.6	0.1	**35.0**
Low bound of cannabis-attributable court costs ($million)	12.5	3.4	9.0	0.0	0.4	0.3	0.0	**25.7**
High bound of cannabis-attributable court costs ($million)	20.9	6.1	18.3	0.0	0.7	1.1	0.3	**47.6**
Magistrates Courts								
Number of defendants finalised	94,859	53,509	51,898	205,810	39,331	41,628	10,647	497,697
Total defendant weeks	1,007,171	425,048	212,782	1,049,631	184,856	180,408	59,623	3,119,519
Assumed court costs ($million)	142.7	60.2	30.1	148.7	26.2	25.6	8.4	442.0
Central estimate of cannabis-attributable court costs ($million)	10.8	6.1	3.9	2.5	1.9	1.7	0.3	**27.2**
Low bound of cannabis-attributable court costs ($million)	8.3	4.5	2.7	0.7	1.4	0.9	0.0	**18.6**
High bound of cannabis-attributable court costs ($million)	14.0	8.1	5.5	8.8	2.6	3.1	1.4	**43.4**

Source: ABS (2017a); Steering Committee for the Review of Government Service Provision, (2017b); Australian Institute of Criminology Drug Use Monitoring Australia collection 2015/16 [computer file]; calculations by the authors.
DUI = driving under the influence.

In addition to the direct costs of the court system, there are also social costs arising from the costs of public prosecutors (where cases are not prosecuted by police) and legal aid costs, where that is provided to defendants. The costs of counsel funded by defendants themselves are out-of-scope of this report as they are a purely private cost.

State and territory governments have legal aid commissions that provide legal support in criminal, civil and family law matters. Both Moore (2005) and Ritter et al. (2013) used a top-down approach to allocate a proportion of these costs to substance use, which we replicated. First, we estimated the average proportion of court activity considered attributable to cannabis use (e.g. our estimated cannabis-attributable court costs divided by the total Higher Court and Magistrate's courts estimates, see Table 7.4 for the source data). This proportion was estimated to be 7.6 percent [28].

[28] (35.0 + 27.2)/ (379.4 + 442.0) = 0.075724 = 7.6%.

Expenditure figures were sourced from the annual reports of each of the Legal Aid Commissions across Australia for 2015/16 (Justice and Community Safety Directorate, 2016b; Legal Aid Commission New South Wales, 2016; Legal Aid Queensland, 2016; Legal Services Commission of South Australia, 2016; Northern Territory Legal Aid Commission, 2016; The Treasurer, 2015; Victoria Legal Aid, 2016). It was not possible to identify the spending on criminal matters from the ACT and NT data and so these jurisdictions are excluded from the calculation. Legal aid organisations for which data are available are estimated to have spent $306.8 million on criminal matters. Assuming the share of legal aid costs on Children's court matters matches the share of Children's court costs (3.8%) in total court costs, we estimate legal aid costs on adult criminal court matters at $295.3 million, with a central estimate of cannabis-attributable costs of **$22.3** million, with a low bound of $15.9 million and a high bound of $32.7 million (see summary Table 7.18).

State and territory government spending on Department of Public Prosecution (DPP) services was $408.4 million in 2015/16 (Commonwealth Director of Public Prosecutions, 2016; Director of Public Prosecutions, 2016; Director of Public Prosecutions Northern Territory, 2016; Justice and Community Safety Directorate, 2016a; Office of the Director of Public Prosecutions, 2016; The Treasurer, 2016, 2017). As was done for Legal Aid Commission expenditure, we applied a multiplier to this total expenditure to derive a cannabis specific public prosecution expenditure. We estimated this multiplier from the average of Higher and Magistrates' court activity figures, weighted by expenditure (as described earlier) as 7.6 percent.

As with legal aid costs, it has been assumed that the DPP costs on Children's court matters matches their share of direct court costs (3.8%) giving $393.1 million in DPP costs related to adult criminal court matters, with a central estimate of cannabis-attributable costs of **$29.7 million**, with a low bound estimate of $21.2 million and an high bound of $43.5 million (see summary Table 7.18).

7.4 Correction system costs

Conceptually there are two ways that the correction costs attributable to cannabis could be calculated. The first is to calculate the NPV of all future corrections related costs arising from cannabis-attributable crime committed in 2015/16. The second approach is to calculate the corrections system related costs attributable to cannabis incurred due to imprisonment in 2015/16, regardless of when the offence itself occurred.

The former approach has the advantage of being based on crime committed in the study year (or at least criminal proceedings finalised in the study year) reflecting the pattern of cannabis use and crime in the study year. The latter has the advantage of being based on known costs and known prison populations.

In this study we have adopted the NPV approach, calculating the correction system costs of crime committed in 2015/16.

7.4.1 Estimating the unit costs of imprisonment

The on-going net recurrent costs (including depreciation of capital items) of corrections facilities to society totalled $3.9 billion in 2015/16: $2.9 billion in capital costs and $1.0 billion in operating costs (Steering Committee for the Review of Government Service Provision, 2017b). As at 30 June 2016 there were 38,845 individuals detained in the adult corrections system including prisoners on remand (Australian Bureau of Statistics, 2017g). This gives an annual correction system cost per prisoner of $99,769. We have used this average in calculating the cost per cannabis-attributable prisoner although this is likely to underestimate the true per prisoner costs, as it excludes some of the costs associated with in-prison drug and alcohol services. We do not have data that would allow us to isolate the cost of these services from the overall prison costs.

There are other less direct costs and offsetting benefits associated with imprisonment, with researchers at the AIC identifying the following additional forms of cost and offsetting savings (Morgan and Althorpe, 2014):

Costs

- Lost productivity of prisoners (paid and unpaid work);
- Workplace disruption and costs of recruiting replacement employees;
- Lost potential lifetime economic output as ex-prisoners have a lower employment participation rate post release;
- Increased risk of homelessness post release;
- Prison assaults (on both staff and prisoners);
- Additional government payments as a result of household income falling due to imprisonment of a member of the household who was in work;
- Health impacts of imprisonment such as transmission of blood-borne viruses;
- Cost-of-out of home care for children whose custodial parent is imprisoned and who cannot be placed with another member of the immediate family; and,
- Childcare and parenting support costs.

Offsetting savings

- Reduced government payments;
- Incapacitation effect of imprisonment (e.g. it is more difficult for imprisoned offenders to commit additional crime (excluding prison assaults);
- Value of work completed in prison;
- Reduction in illicit drug use by prisoners (although it should be noted that although rates of drug use are likely to fall during imprisonment, the harms per person arising from use may actually increase, for example through increased sharing of needles);
- Reduction in alcohol use (and therefore associated harms) by prisoners; and,
- Reduction in access to welfare services by prisoners.

Unfortunately, many of these costs cannot be accurately quantified from the available data. Our estimate of the net costs of imprisonment was therefore restricted to the following annual costs (with the method used to quantify the amount set out in the discussion that follows):

- Recurrent costs of corrections facilities: **$99,769** / prisoner (calculation set out above);
- Lost productivity of prisoners in paid work: **$23,843** / male prisoner and **$10,684** / female prisoner;
- Workplace disruption and costs of recruiting replacement employees **$3,017** / male prisoner and **$1,352** / female prisoner;
- Lost productivity of prisoners in unpaid household work: **$19,685** / male prisoner and **$35,146 /** female prisoner;
- Prison assaults (on both staff and prisoners): **$489**; and,
- Reduced government payments (offsetting saving): **-$2,848** / male prisoner and **-$3,363** / female prisoner.

7.4.1.1: Lost productivity of prisoners in paid work

A proportion of offenders were in paid work at the time that they were arrested. For these individuals there is a social cost from the loss of the economic output that would have been produced had they remained in the labour force. Gross domestic product per employee was calculated from current price estimates of GDP for the year to June 2016 from the ABS national accounts and average employment over 2015/16 (Australian Bureau of Statistics, 2019a, d) and was $139,697 [29].

Unlike the mortality data, this calculation excluded the estimated portion of income flowing to the person using cannabis themselves. This is partially because criminal behaviours are not as directly linked to dependence in the way that medical harms are linked, and partially because if they were included, then income would need to be offset against any savings in living expenses for the imprisoned persons, for which data are not available. The average labour share of GDP over the past 20 years has been 54 percent, and so only 46 percent ($63,933) of the 'per employee' GDP has been included as a cost in this corrections cost calculations.

Data from the 2013/14 Victorian crime statistics (Victoria Police, 2014) indicates that 37 percent of male adult alleged offenders and 17 percent of female adult alleged offenders were in employment when they were arrested (more up to date data on the employment status of alleged offenders does not appear to be available). We have assumed that these employment rates are representative of those arrested for cannabis-attributable offences. These parameters give an estimated annual loss to economic output of **$23,843** per male prisoner and **$10,684** per female prisoner.

7.4.1.2: Workplace disruption and costs of recruiting replacement employees

Employers face one-off costs to recruit new employees to replace imprisoned workers, and to train those new workers. We have assumed that these costs match the costs estimated by the Bureau of Infrastructure, Transport and Regional Economics for replacing deceased employees, namely $6,422 in 2006 values (Bureau of Infrastructure Transport and Regional Economics, 2009). Converting to 2015/16 values using the change in the CPI (Australian Bureau of Statistics, 2019c) gives a cost per imprisoned employee of $8,119. Applying the employment shares for alleged offenders (37% for males and 17% for females) (Victoria Police, 2014) gives an estimated average cost to employers of replacing imprisoned workers of **$3,017** per male prisoner and **$1,352** per female prisoner.

7.4.1.3: Lost productivity of prisoners in unpaid household work

The estimated value of labour in the household lost due to imprisonment is calculated on the same basis as that lost due to premature mortality (see Chapter 3). Following Collins and Lapsley, production losses in the household sector are valued on an individual function replacement basis using data from the ABS publication Unpaid Work and the Australian Economy 1997 (Australian Bureau of Statistics, 1997; Collins and Lapsley, 2008). The total value of male unpaid labour in the household is estimated at $82 billion in 2007 values and female unpaid labour is valued at $154 billion. Converting these figures to per adult estimates using the population data used in the ABS estimates of the value of unpaid household labour (Australian Bureau of Statistics, 1997) and to 2015/16 values using the CPI (Australian Bureau of Statistics, 2019c) gives values of unpaid household work of **$19,613** per adult male and **$35,016** per adult female.

---

[29] This GDP per worker is slightly different than that used in the recently released report into the social cost of smoking as the ABS has made minor revisions to their estimates of current prices, GDP and employment for 2015/16 since the smoking analysis was completed.

7.4.1.4: Prison assaults

Data from the Review of Government Services Provision (Steering Committee for the Review of Government Service Provision, 2017b) estimates that in 2015/16, 1.1 percent of prisoners were the victim of a serious assault and 13.6 percent were the victim of an assault, with 0.04 percent of prisoners having committed a serious assault on a prison guard and 1.4 percent having committed an assault on a prison guard.

The estimated cost per assault was taken from Smith et al.'s (2014) estimates of the costs of crime in Australia (see Table 7.10). Serious assaults were assumed to be equivalent to assaults requiring hospitalisation. Other assaults were costed at the average cost of the other assault categories reported in Smith et al. (2014) and weighted based on their relative frequency amongst assaults. For assaults on prisoners, the productivity costs were not included. Medical costs outside of hospital have been excluded for prisoners as it has been assumed that they are included in the overall recurrent costs of prisons.

It is less obvious whether productivity costs should be included for prison guards; to the extent to which these costs are borne directly by the corrections system then they will be included in the overall recurrent operating costs and should not be included in this calculation. However, to the extent they are borne by the employee through unpaid time off, or by workers compensation funds they will not be included in the recurrent costs and should be included in our costing [30]. The estimated cost per assault on prisoners was $26,882 for serious assaults and $1,054 for other assaults, and the costs per assault on a prison guard were $61,852 and $1,751 respectively, if productivity costs are included. Applying the relative frequencies to these unit costs, the estimated annual cost per prisoner from prison assaults (both on other prisoners and on prison guards) is **$489**.

7.4.1.5: Reduced government payments (offsetting saving)

Prisoners are not eligible for government income support payments whilst in detention so, to the extent that detainees were unemployed and on benefits at the time of their offence, there will be a cost saving for the Australian Government. We have not been able to identify data on the proportion of offenders who were in receipt of income support benefits at the time of their imprisonment, however the 2013/14 Victorian crime statistics (Victoria Police, 2014) reported that 21 percent of male alleged offenders and 25 percent of female alleged offenders were unemployed at the time of their arrest (with the remainder being not in the labour force). The annual value of Newstart allowance for singles in 2015/16 was $14,606 (Centrelink, 2015). Assuming that these rates of unemployment are representative of prisoners detained for a cannabis-attributable offence at the time of their arrest, and that all unemployed alleged offenders were in receipt of Newstart allowance at the time of their offence, this gives average offsetting savings of **-$3,082** per male prisoner and **-$3,639** per female prisoner. These estimates are likely to overstate the potential cost savings, as not all of those who are unemployed are eligible for Newstart allowance (in which case there would be no offsetting benefit) and of those eligible some would have a partner who was also in receipt of income support benefits (in which case the cost saving would be the difference between two persons in receipt of the couples Newstart allowance and one person in receipt of the single Newstart allowance which is $9,771). On the other hand at least some unemployed prisoners would have

---

[30] The costs of cannabis attributable prison assaults on prison guards should be additional to any workplace costs reported in Chapter 6. This is because the attribution of workplace injuries to cannabis in Chapter 6 is based on the prevalence of cannabis use of employees, as it is reporting the estimated cost of injuries caused by the cannabis use of an employee (whether the injury is to the person who had used the cannabis or to one of their colleagues). The estimate in section 7.4.1.4 is calculating the expected increase in assaults of prison guards due the higher prison population that results from cannabis attributable crime, no assumption is made as to whether cannabis use has continued in prison.

been in receipt of a more generous benefit such as the Disability Support Pension, or be in receipt of other payments such as rent assistance or family tax benefit, and for those individuals the offsetting saving will be underestimated.

Combining the six sources of cost and offsetting benefit from imprisonment that were able to be quantified gives a total estimated net average annual cost of imprisonment in 2015/16 of **$143,721** for male prisoners and **$143,801** for female prisoners. It is not known whether the net costs would be higher or lower if all of the unquantifiable costs were able to be quantified.

7.4.2 Estimating the total costs of cannabis-attributable imprisonment

The estimated total cost of cannabis-attributable imprisonment in 2015/16 can be estimated from the total number of persons sentenced to custody in 2015/16, the expected duration of their sentences, and the proportion of imprisoned persons whose offending was attributable to cannabis (Table 7.5).

Data on the number of persons sentenced to custody were taken from the ABS publication 'Criminal Courts, 2015/16' (2017a) using the data on number of persons found guilty and sentenced to 'custody in a correctional institution'. The duration that will be served by those sentenced in 2015/16 cannot be known at this point in time. As a proxy we used the mean time served by offence category for persons who have completed their sentence from the ABS publication 'Prisoners in Australia' (2016d). Cannabis-attributable persons imprisoned were calculated using the AF derived from the DUMA survey.

The unit cost of imprisonment used was that calculated in Section 7.4.1. This was applied for each year (or fractional year) that a person convicted of that offence would be expected to remain in custody. For instance, each person convicted of homicide the annual costs are incurred for 15 years, for each person convicted of assault the costs are incurred for two years, and so on. Costs arising from lost economic output, and the costs of assaults in prison, increase at the expected nominal rate of growth in GDP per capita, other costs are expected to grow in line with the CPI. This series of future costs are converted to a present value using a real discount rate of 7 percent.

Table 7.5: Adult prisoners sentenced in 2015/16, total and cannabis-attributable by most serious offence category

Most serious offence category	Total persons sentenced to custody	Mean duration of time served (years)	Persons sentenced to custody for a cannabis-attributable offence		
			Central estimate	low bound	High bound
01 Homicide and related offences	251	15.0	19.0	14.7	24.6
02 Acts intended to cause injury	11,816	2.0	895.9	690.5	1156.2
03 Sexual assault and related offences	1,678	5.8	127.2	98.1	164.2
04 Dangerous or negligent acts endangering persons	2,747	1.5	208.3	160.5	268.8
05 Abduction, harassment and other offences against the person	600	3.6	45.5	35.1	58.7
06 Robbery, extortion and related offences	1,392	3.6	105.5	81.3	136.2
07 Unlawful entry with intent/burglary, break and enter	3,769	2.1	379.7	282.2	506.2
08 Theft and related offences	3,783	1.1	381.2	283.2	508.0
09 Fraud, deception and related offences	1,671	1.9	168.4	125.1	224.4
10 Illicit drug offences	4,451	3.8	570.1	395.8	805.8
11 Prohibited and regulated weapons and explosives offences	1,601	1.9	121.4	93.6	156.7
12 Property damage and environmental pollution	996	2.0	66.4	35.3	121.4
13 Public order offences	654	1.5	65.4	34.8	119.5
14 Traffic and vehicle regulatory offences	2,123	0.6	21.4	5.9	75.4
15 Offences against justice procedures, government security and government operations	3,282	1.2	241.8	180.4	322.0
16 Miscellaneous offences	139	4.5	4.5	0.8	22.5
Total	**40,953**		3421.8	2517.2	4670.5

Sources: ABS, (2016d); Australian Institute of Criminology Drug Use Monitoring Australia collection 2015/16 [computer file]; calculations by the authors.

The total estimated cost of cannabis-attributable imprisonment is **$1,122.2** million, with a low bound of $824.4 million and a high bound of $1,529.9 million (Table 7.6). The majority of the costs arise from the costs of operating and maintaining prisons.

Table 7.6: Expected total cost of imprisonment for persons sentenced in 2015/16 for cannabis-attributable crime, net present values

Cost items	Present value of cost, central estimate ($)	Present value of cost, low bound ($)	Present value of cost, high bound ($)
Cost of imprisonment	785,848,091	577,292,000	1,071,376,614
Value of lost economic output	176,604,106	129,739,998	240,758,016
Additional recruitment costs	21,437,430	15,748,154	29,226,465
Value of lost labour in household	156,422,322	114,909,429	213,256,506
Cost of prison assault	3,765,474	2,766,259	5,133,336
Offsetting saving in reduced benefit payments	-21,880,711	-16,073,793	-29,830,806
Total net costs	**1,122,196,713**	**824,382,047**	**1,529,920,130**

7.4.3 Community based correction costs

The cost of community corrections arising from cannabis-attributable offences, where the sentence was imposed in 2015/16, was estimated from ABS data on the number of persons sentenced to community service orders (and the average length of the orders) by broad offence type (Australian Bureau of Statistics, 2017a) [31] and data on the total cost of the community corrections system (Steering Committee for the Review of Government Service Provision, 2017b). It was assumed that the cost of a given order was directly proportional to the length of the order, with the average cost per order converted to a per hour cost ($80.99) using the mean number of hours for all orders. The data on the mean duration of community service orders does not include those orders where the MSO was 'homicide'. For the purposes of the calculation we have assumed that the mean duration for these orders was the same as for 'Acts intended to cause injury'. This is likely to understate the mean duration of community service orders for persons sentenced for homicide. Data on mean duration is also not available for the MSO category 'Miscellaneous offences'. In the absence of any comparable offence category we have excluded these offences from the cost calculations.

The mean duration data are also based on a smaller sample for orders issued where the MSO is 'Acts intended to cause injury'. The ABS records 7,987 persons as having been sentenced to a community service order where this was their MSO, however in calculating the mean duration data the ABS only had duration information for 4,130 persons sentenced for this offence category (Australian Bureau of Statistics, 2017a). For the cost calculations we have assumed that community service orders where the duration is not known by the ABS have the same median duration as those whose duration is known. All other MSO categories have the same sample size.

Attribution to cannabis was based on the AF calculated from the DUMA survey with a central estimate of 304,957 hours of community supervision attributable to cannabis (Table 7.7). This equates to a cost of **$24.7 million** for cannabis-attributable community supervision orders in 2015/16 under the central estimate of cannabis-attribution, with a low bound of $17.9 million and a high bound of $34.7 million.

[31] Note that not all forms of non-custodial orders are included in the ABS statistics (2017e). Home detention, probation, good behaviour bonds and suspended sentences are not included. These types of orders generally require minimal administration and supervision, however, so the impact of their omission is reduced.

Table 7.7: Community supervision orders, total and cannabis-attributable, 2015/16

Most serious offence category	Number of community supervision orders	Mean duration (hours)	Cannabis-attributable hours central estimate	Cannabis-attributable hours low bound	Cannabis-attributable hours high bound
01 Homicide and related offences	15	114.4 [a]	130.1	100.3	167.9
02 Acts intended to cause injury	7,987	114.4 [b]	69,280.1	53,391.8	89,405.1
03 Sexual assault and related offences	562	147.1	6,268.3	4,830.7	8,089.1
04 Dangerous or negligent acts endangering persons	2,352	118.7	21,168.3	16,313.7	27,317.5
05 Abduction, harassment and other offences against the person	680	108.9	5,614.8	4,327.1	7,245.8
06 Robbery, extortion and related offences	459	178.5	6,212.3	4,787.6	8,016.8
07 Unlawful entry with intent/burglary, break and enter	2,742	110.6	30,555.7	22,704.7	40,727.3
08 Theft and related offences	3,942	84.3	33,482.2	24,879.3	44,628.0
09 Fraud, deception and related offences	1,959	122.3	24,139.6	17,937.2	32,175.4
10 Illicit drug offences	4,023	114.6	59,048.9	40,997.1	83,469.8
11 Prohibited and regulated weapons and explosives offences	1,421	102.6	11,054.5	8,519.3	14,265.7
12 Property damage and environmental pollution	1,724	73.9	8,493.6	4,518.6	15,523.5
13 Public order offences	1,504	75.2	7,540.1	4,011.3	13,780.8
14 Traffic and vehicle regulatory offences	3,713	108.3	6,758.3	1,858.3	23,810.5
15 Offences against justice procedures, government security & government operations	2,859	72.2	15,209.9	11,347.5	20,250.5
16 Miscellaneous offences	169	[c]	n/a	n/a	n/a
Total hours of community supervision orders	**3,741,100**	**103.6**	304,957	220,525	428,874
Total cost of community supervision orders			**24,699,877**	**17,861,323**	**34,736,527**

Source: (Australian Bureau of Statistics, 2017a; Steering Committee for the Review of Government Service Provision, 2017b) calculations by the authors. n/a = not applicable.

[a] Duration data is not available for community supervision orders where the most serious offence was homicide; mean duration for 'Acts intended to cause injury' has been used to calculate the cost of this offence category.

[b] Mean duration is for the 4,130 orders where the ABS was able to identify the duration of the order.

[c] Duration data was not available for the most serious offence category 'Miscellaneous offences' and it was excluded from the cost calculations.

7.5 Costs to victims of crime

As well as the costs arising from the investigation of crime, the administration of justice and the corrections system, there are also substantial costs incurred by the victims of crime. Administrative data from police and courts authorities are generally poor guides as to the extent of crime victimisation, as many victims do not report the offence to the police. Nationally, estimated reporting rates in 2015/16 for selected crimes varied widely, ranging from 30 percent for sexual assault to 93 percent for motor vehicle theft (Australian Bureau of Statistics, 2017f).

The most comprehensive assessment of the prevalence of crime victimisation in Australia is provided by the ABS's survey 'Crime Victimisation, Australia' (2017f). The number of persons reporting that they had been a victim of crime (or that their household had been a victim of crime for property offences), by offence type, is set out in Table 7.8. It should be noted that the totals cannot be summed to provide an overall number of persons who have been a victim of crime in the reference year as not all crimes are in scope, and some individuals would have been the victim of more than one type of crime. It is also important to note that not all crimes are included in the survey of crime victimisation and for those types of crime costs to victims cannot be calculated.

Table 7.8: Number of victims of selected crimes, 2015/16

Offence	Number of victims of crime – reported latest incident to police ('000)	Number of victims of crime – did not report latest incident to police ('000)	Total number of victims of selected crimes ('000)
Personal Crimes			
Physical assault	253.6	207.8	462.2
Face-to-face threatened assault	200.9	294.7	492.0
Non face-to-face threatened assault	67.7	116.8	182.3
Robbery	36.5	29.7	70.6
Sexual assault victims aged 18 years or older	23.5	53.0	77.4
Household crimes			
Break and enter	173.3	52.7	225.7
Attempted break and enter	80.9	105.0	185.9
Motor vehicle theft	45.2	4.1	48.6
Theft from a motor vehicle	142.9	120.4	264.4
Malicious property damage	234.3	199.3	434.0
Other theft	99.5	140.3	238.9

Source: ABS, (2017f):
Note: Number of victims of crime, not the number of offences. As some victims of crime will have had more than one occasion in the year in which they were the victim of a particular crime type, these data understate the cost of crime to victims.

Applying the relevant AF to the total number of victims of crime gives the numbers where the crime was attributable to cannabis, see Table 7.9. Overall, we estimate that there were 87,500 victims of at least one cannabis-attributable violent crime in 2015/16, and 126,000 households that were victims of some form of cannabis-attributable property crime.

Table 7.9: Number of victims of selected cannabis-attributable crimes, 2015/16

Offence	Number of victims of cannabis-attributable crime – central estimate ('000)	Number of victims of cannabis-attributable crime – low bound ('000)	Number of victims of cannabis-attributable crime – high bound ('000)
Personal Crimes			
Physical assault	35.0	27.0	45.2
Threatened assault	41.2	31.8	53.2
Robbery	5.4	4.1	6.9
Sexual assault victims aged 18 years or older	5.9	4.5	7.6
Household crimes			
Break and enter	22.7	16.9	30.3
Attempted break and enter	18.7	13.9	25.0
Motor vehicle theft	4.9	3.6	6.5
Theft from a motor vehicle	26.6	19.8	35.5
Malicious property damage	28.9	15.4	52.9
Other theft	24.1	17.9	32.1

Sources: ABS (2017f) Australian Institute of Criminology Drug Use Monitoring Australia collection 2015/16 [computer file]; calculations by the authors.
Note: Number of victims of crime, not the number of offences. As some victims of crime will have had more than one occasion in the year in which they were the victim of a particular crime type, these data understate the cost of crime to victims.

A comprehensive set of estimates of the costs of crime have been compiled by researchers at the AIC (Smith et al., 2014). Drawing together information from a range of Australian and international sources on the costs of various types of personal and household crime, they distinguish between medical costs, lost output, property loss, property damage, and intangible cost (e.g. pain and suffering). Although not all forms of crime are in scope, the analysis covers the majority of the crime types included in the ABS victims of crime survey.

Costs of the various forms of personal crime are subdivided by the severity of medical impact on the victim, and the number of victims of cannabis-attributable crime estimated. Table 7.10 has been apportioned between severity categories based on the proportions reported in Smith et al. (2014).

In almost all cases, the parameter values chosen by Smith et al. are consistent with the ranges adopted in comparable international exercises, however the intangible cost estimate adopted for sexual assault is at the lower end of comparable studies (Smith et al., 2014). Smith et al. did not derive a specific estimate for the intangible cost of sexual assault but rather based it on the intangible cost used for assault where the victim was injured, with treatment other than hospitalisation for sexual assault where the victim sustained physical injuries, and assault where the victim was injured and no treatment was required for sexual assault where the victim did not sustain physical injuries (Smith et al., 2014). In contrast, Dolan and colleagues (2005) derived estimates of intangible costs from estimates of the quality of life impact of sexual assault, expressed in terms of DALY using a value of 0.56 lost DALY for rape and 0.16 lost DALY for other sexual assault. This compared to a lost DALY of 0.19 for assault resulting in serious injury (roughly equivalent to the assault – hospitalised category used by Smith and colleagues (2014)).

As it is more closely aligned to the approach taken to intangible costs in other areas of this report we have used the Dolan et al. (2005) estimates of the intangible costs of sexual assault in place of those derived by Smith et al.(2014).

Unit costs for each cost category were converted to 2015/16 values using the change in current price Gross State Product per capita (Australian Bureau of Statistics, 2019d) from June 2011 to June 2016 for intangible costs and lost output, and the CPI for medical costs, property loss and property damage (Australian Bureau of Statistics, 2019c). Table 7.10 sets out the unit costs to victims of personal crime while Table 7.11 reports the unit costs for household crime.

Table 7.10: Unit costs to victims of personal crime converted to 2015/16 values

Personal crime offence	Medical costs ($)	Lost output ($)	Intangible costs ($)
Assault			
Hospitalised	12,699	34,970	14,183
Injured, treatment other than hospital	755	2,923	3,031
Injured no treatment	-	725	725
No injury	-	43	433
Sexual assault			
Injury	1,040	6,929	41,658
No injury	0	57	10,974
Robbery			
Hospitalised	12,699	34,970	13,988
Injured, treatment other than hospital	755	2,923	3,069
Injured no treatment	-	731	725
No injury	-	43	433

Sources: ABS (2019c, d); Smith et al., 2014, Dolan et al. 2005, calculations by the authors.

Table 7.11: Unit costs to victims of property crime from Smith et al. converted to 2015/16 values

Personal crime offence	Property loss & property damage ($)	Lost output ($)	Intangible costs ($)
Burglary [a]			
Completed	1,911	87	1,135
Attempted	234	57	756
Motor vehicle theft	4,345	174	2,472
Theft from a vehicle [b]	1,135	63	822
Malicious property damage	621	47	1,346
Other theft	559	10	250

Sources: ABS, (2019c, d); Smith et al., (2014), calculations by the authors.

[a] The unit cost used for burglary is that for burglaries of private residences, as we do not have an estimate for the number of victims of burglaries of commercial properties.

[b] These costs are the average for thefts from private and from commercial vehicles.

Applying the unit costs outlined in Tables 7.10 to the central estimate of the number of victims of cannabis-attributable crime in 2015/16 gives a total estimated cost to victims of personal crime of **$406.8 million** (Table 7.12). Assaults account for 55 percent of the victims of crime costs, with sexual assault accounting for a further 41 percent. We did not identify any cases of premature deaths due to cannabis-attributable homicide. In addition, no cases were identified in Chapter 3 via inspection of the NCIS data.

Table 7.12: Central estimate of total costs to victims of cannabis-attributable personal crimes by offence type and severity, 2015/16

Offence	No. of cannabis-attributable victims	Medical costs ($)	Lost output ($)	Intangible costs ($)	Total costs ($)
Assault					
Hospitalised	1,430	18,155,014	49,994,617	20,276,454	88,426,085
Injured, treatment other than hospital	12,359	9,335,618	36,127,663	37,465,725	82,929,007
Injured no treatment	21,257	0	15,419,595	15,419,595	30,839,191
No injury	41,210	0	1,784,672	17,846,724	19,631,396
Total	**76,255**	**27,490,633**	**103,326,548**	**91,008,498**	**221,825,678**
Sexual assault					
Injury	2,609	2,712,894	18,074,709	108,665,609	129,453,211
No injury	3,260	0	187,075	35,776,505	35,963,581
Total	**5,869**	**2,712,894**	**18,261,784**	**144,442,114**	**165,416,792**
Robbery					
Hospitalised	187	2,379,291	6,552,005	2,620,802	11,552,098
Injured, treatment other than hospital	731	551,955	2,135,994	2,242,794	4,930,743
Injured no treatment	956	0	698,306	693,133	1,391,439
No injury	3,479	0	150,687	1,506,874	1,657,562
Total	**5,353**	**2,931,246**	**9,536,993**	**7,063,603**	**19,531,842**
All Personal Crime					
Total	**87,477**	**33,134,772**	**131,125,324**	**242,514,216**	**406,774,312**

Sources: ABS (2019c, d); Smith et al., (2014), Dolan et al. (2005), Australian Institute of Criminology Drug Use Monitoring Australia collection 2015/16 [computer file]; calculations by the authors.

The costs of cannabis-attributable property crime shown in Table 7.13 in 2015/16 had a central estimate of the total cost as **$256.9 million**. Burglaries (completed and attempted) are the most significant driver of the cost accounting for 35 percent of the total.

Table 7.13: Central estimate of total costs to victims of cannabis household crimes in Australia by offence type and severity, 2015/16

Offence	No. of cannabis-attributable cases	Costs of property loss & property damage ($)	Cost of lost output ($)	Intangible costs ($)	Total costs ($)
Burglary	41,471	47,855,521	3,044,454	39,957,375	90,857,349
Completed	*22,741*	*43,467,377*	*1,969,660*	*25,802,548*	*71,239,585*
Attempted	*18,730*	*4,388,143*	*1,074,793*	*14,154,827*	*19,617,764*
Motor vehicle theft	4,897	21,276,736	853,556	12,103,527	34,233,818
Theft from a vehicle	26,640	30,243,207	1,672,858	21,891,372	53,807,437
Malicious property damage	28,933	17,953,390	1,346,999	38,956,457	58,256,845
Other theft	24,071	13,465,568	234,546	6,020,019	19,720,134
Total	**126,011**	**130,794,422**	**7,152,413**	**118,928,749**	**256,875,584**

Sources: ABS (2019c, d); Smith et al., (2014), Dolan et al. (2005), Australian Institute of Criminology Drug Use Monitoring Australia collection 2015/16 [computer file]; calculations by the authors: Note: values may not sum due to rounding.

Tables 7.14 and 7.15 set out the estimated cost of cannabis-attributable crime if the low bound estimate of the share of crime attributable to cannabis is used, and Tables 7.16 and 7.17 show the estimated cost of crime if the high bound estimate for the AF is used.

The plausible range of the costs to victims of cannabis-attributable violent crime ranges from a low bound of $313.5 million to a high bound of $524.9 million.

Similarly, the plausible range of the costs of cannabis-attributable property crime ranges from a low bound of $178.6 million to a high bound of $371.2 million.

Table 7.14: Low bound estimate of total costs to victims of cannabis-attributable personal crimes by offence type and severity, 2015/16

Offence	No. of cannabis-attributable victims	Medical costs ($)	Cost of lost output ($)	Intangible costs ($)	Total costs ($)
Assault					
Hospitalised	1,102	13,991,451	38,529,146	15,626,372	68,146,969
Injured, treatment other than hospital	9,524	7,194,643	27,842,358	28,873,557	63,910,558
Injured no treatment	16,382	0	11,883,356	11,883,356	23,766,713
No injury	31,759	0	1,375,386	13,753,861	15,129,247
Total	**58,767**	**21,186,093**	**79,630,247**	**70,137,146**	**170,953,486**
Sexual assault					
Injury	2,010	2,090,735	13,929,562	83,744,879	99,765,176
No injury	2,513	0	144,172	27,571,733	27,715,905
Total	**4,523**	**2,090,735**	**14,073,734**	**111,316,612**	**127,481,081**
Robbery					
Hospitalised	144	1,833,639	5,049,407	2,019,763	8,902,808
Injured, treatment other than hospital	563	425,373	1,646,138	1,728,445	3,799,955
Injured no treatment	736	0	538,160	534,174	1,072,335
No injury	2,682	0	116,130	1,161,297	1,277,426
Total	**4,125**	**2,259,011**	**7,349,835**	**5,443,678**	**15,052,524**
All Personal Crimes	**67,415**	**25,535,839**	**101,053,816**	**186,897,436**	**313,487,091**

Sources: ABS (2019c, d); Smith et al., (2014), Dolan et al. (2005); Australian Institute of Criminology Drug Use Monitoring Australia collection 2015/16 [computer file]; calculations by the authors.

Table 7.15: Low bound estimate of total costs to victims of cannabis household crimes in Australia by offence type and severity, 2015/16

Offence	No. of cannabis-attributable cases	Costs of property loss & property damage ($)	Cost of lost output ($)	Intangible costs ($)	Total costs ($)
Burglary	30,815	35,559,516	2,262,211	29,690,721	67,512,448
Completed	*16,898*	*32,298,863*	*1,463,575*	*19,172,837*	*52,935,276*
Attempted	*13,918*	*3,260,653*	*798,636*	*10,517,884*	*14,577,173*
Motor vehicle theft	3,639	15,809,888	634,243	8,993,645	25,437,776
Theft from a vehicle	19,795	22,472,513	1,243,034	16,266,599	39,982,147
Malicious property damage	15,393	9,551,266	716,608	20,724,970	30,992,844
Other theft	17,886	10,005,723	174,282	4,473,235	14,653,240
Total	**87,527**	**93,398,907**	**5,030,378**	**80,149,170**	**178,578,454**

Sources: ABS (2019c, d); Smith et al., (2014), Dolan et al. (2005); Australian Institute of Criminology Drug Use Monitoring Australia collection 2015/16 [computer file]; calculations by the authors.

Table 7.16: High bound estimate of total costs to victims of cannabis-attributable personal crimes by offence type and severity, 2015/16

Offence	No. of cannabis-attributable victims	Medical costs ($)	Cost of lost output ($)	Intangible costs ($)	Total costs ($)
Assault					
Hospitalised	1,845	23,428,812	64,517,407	26,166,502	114,112,721
Injured, treatment other than hospital	15,949	12,047,495	46,622,283	48,349,034	107,018,812
Injured no treatment	27,432	0	19,898,788	19,898,788	39,797,577
No injury	53,180	0	2,303,097	23,030,966	25,334,063
Total	**98,406**	**35,476,306**	**133,341,575**	**117,445,291**	**286,263,172**
Sexual assault	.	.	.	.	.
Injury	3,366	3,500,955	23,325,178	140,231,565	167,057,697
No injury	4,207	0	241,418	46,169,118	46,410,536
Total	**7,573**	**3,500,955**	**23,566,596**	**186,400,683**	**213,468,233**
Robbery	.	.	.	.	.
Hospitalised	242	3,070,444	8,455,278	3,382,111	14,907,834
Injured, treatment other than hospital	943	712,290	2,756,473	2,894,297	6,363,060
Injured no treatment	1,233	0	901,155	894,479	1,795,634
No injury	4,490	0	194,460	1,944,602	2,139,062
Total	**6,908**	**3,782,735**	**12,307,366**	**9,115,489**	**25,205,589**
All Personal Crimes	**112,887**	**42,759,996**	**169,215,536**	**312,961,463**	**524,936,995**

Sources: ABS (2019c, d); Smith et al., (2014), Dolan et al. (2005), Australian Institute of Criminology Drug Use Monitoring Australia collection 2015/16 [computer file]; calculations by the authors.

Table 7.17: High bound estimate of total costs to victims of cannabis household crimes in Australia by offence type and severity, 2015/16

Offence	No. of cannabis-attributable cases	Costs of property loss & property damage ($)	Cost of lost output ($)	Intangible costs ($)	Total costs ($)
Burglary	55,276	63,786,110	4,057,920	53,258,756	121,102,786
Completed	30,311	57,937,201	2,625,339	34,391,939	94,954,479
Attempted	24,966	5,848,909	1,432,581	18,866,817	26,148,307
Motor vehicle theft	6,527	28,359,533	1,137,695	16,132,661	45,629,890
Theft from a vehicle	35,508	40,310,847	2,229,735	29,178,775	71,719,356
Malicious property damage	52,881	32,813,050	2,461,883	71,199,933	106,474,866
Other theft	32,083	17,948,112	312,624	8,024,019	26,284,755
Total	**182,275**	**183,217,652**	**10,199,857**	**177,794,144**	**371,211,652**

Sources: ABS (2019c, d); Smith et al., (2014), Dolan et al. (2005), Australian Institute of Criminology Drug Use Monitoring Australia collection 2015/16 [computer file]; calculations by the authors.

7.6 Conclusions

This analysis has provided estimates of cannabis-attributable crime costs among adults in Australia during the 2015/16 financial year. The cost estimates are summarised in Table 7.18. A feature of this research was that it used the DUMA survey conducted in several police commands in Australia to obtain estimates of the extent to which inmates arrested for different offence types attributed their arrest to having used cannabis recently. Overall, the cannabis-attributable percentages were higher than they were for heroin (3.4% (Whetton et al., 2020)), with 8.0 percent of all detainees attributing their arrest to cannabis, but significantly lower than the attribution for methamphetamine (16.2% (Whetton et al., 2016)). This cannabis-attribution did vary by the MSO, and was higher for those with illicit drug offences (12.8%) and property offences (10.1%). These cannabis-attributions were then applied to a range of different national crime statistics reported by the ABS for 2015/16 (2017a, e, f, g).

Table 7.18: Summary of cannabis-attributable crime costs, 2015/16

Cost area	Central estimate ($)	Low bound ($)	High bound ($)
Police (Table 7.3)	474,751,003	326,354,686	930,277,313
Court (Table 7.4)	62,157,879	44,268,932	90,930,267
Legal Aid	22,343,893	15,913,353	32,686,703
Public Prosecutors	29,743,305	21,183,224	43,511,244
Prisoners sentenced (Table 7.6)	1,122,196,713	824,382,047	1,529,920,130
Community correction (Table 7.7)	24,699,877	17,861,323	34,736,527
Personal crime victim (Tables 7.12, 7.14, 7.16)	406,774,312	313,487,091	524,936,995
Household crime victim (Tables 7.13, 7.15, 7.17)	256,875,584	178,578,454	371,211,652
Total	**2,399,542,566**	**1,742,029,110**	**3,558,210,831**

The cannabis-attributable cost of police dealing with adult offenders was $474.8 million. This attributable cost was particularly high for violent offenders ($159.3 million). For adult offenders, matters finalised in Higher and Magistrates courts the total cannabis-attributable court costs was $62.2 million. The effect of cannabis-attribution was also examined for legal aid costs and the costs of public prosecutors. For legal aid the cannabis-attributable cost was $22.3 million and for public prosecutors it was $29.7 million.

Correction system costs were examined by firstly looking at costs of prisoners sentenced during 2015/16 and secondly looking at community-based correction costs. The cannabis-attributable costs of prisoners sentenced during 2015/16 was $1.1 billion. The cannabis-attributable community correction costs were $24.7 million during the same 12-month period.

Costs related to victims of personal crime and of household crime were also examined for 2015/16. Cannabis-attributable personal crimes were $406.8 million while cannabis-attributable household crimes were $256.9 million. Summing across the eight cost areas shown in Table 7.18 the central estimate of cannabis-attributable crime was **$2.4 billion**. The low bound costs for this was $1.7 billion and the high bound cost was $3.6 billion.

7.7 Limitations

As with our previous studies on illicit drugs (Whetton et al., 2016; Whetton et al., 2020) there were a range of costs relating to criminal justice that we knew to exist, but we were unable to quantify. For example, our estimate does not include any budget allocation for the Australia Federal Police, juvenile offenders or any component relating to the protection of Australia's borders and prevention of importation of illicit cannabis. In addition, this analysis does not assess the cost associated with either diversion programs or specialist drug courts.

There is also considerable debate, which it is not possible to resolve in this analysis, on the extent to which cannabis use is a causal factor for crime or whether it is simply a correlation of demographic groups which are more likely to use cannabis also being more likely to be involved with the criminal justice system (Arendt et al., 2013; Norström and Rossow, 2014). Thus, given the lack of data about cannabis' direct contribution to specific crimes, it is possible that these estimates under-or over-estimate cannabis' contribution to some categories of crime.

Acknowledgements

The Australian Institute of Criminology (AIC) provided DUMA-based estimates of cannabis AF. The DUMA project is funded by the Australian Government. The data (and tabulations) used in this publication were made available through the AIC. These data were originally collected by the AIC as an independent data collector with the assistance of New South Wales, Northern Territory, Queensland, South Australian, Victorian and Western Australian Police. Neither the collectors, the police, nor the AIC bear any responsibility for the analyses or interpretations presented herein.

We especially acknowledge the advice and assistance given by Tom Sullivan, Samantha Bricknell and Alexandra Voce. We also thank Anna Ferrante of Curtin University for her statistical advice.

CHAPTER 8: ROAD CRASHES

Steve Whetton & Tania Dey

8.1 Background

There are a number of substances where driving whilst intoxicated can increase the rates at which transport crashes occur. The increase in risk arises from impairment to the cognitive and psychomotor skills necessary to drive safely including reductions in attentiveness, poor judgement and increased impulsiveness, reduce lane control, increased reaction times, and other impairments to fine and gross motor skills (Drummer et al., 2003; Verstraete and Legrand, 2014). Evidence from crash studies suggests that alcohol and cannabis are the substances that cause the greatest number of road crash fatalities and hospitalisations, due to their greater population consumption prevalence and also to the nature of their effect on cognitive and psychomotor skills (Ch'ng et al., 2007; Drummer et al., 2003; Verstraete and Legrand, 2014).

In the case of cannabis, studies have found that it has a significant impact on psychomotor skills including "motor control, psychomotor speed, executive function, motor impulsivity, visual processing, short-term memory, working memory (reaction time and accuracy), perception and balance" (Verstraete and Legrand, 2014, p.33). The impact on risk taking behaviour is more ambiguous, and there is some evidence that persons who use cannabis, particularly where the dose has been relatively low, will try to drive more cautiously to offset the impacts on driving ability, although this increased caution is not able to offset the increase in risk (Verstraete and Legrand, 2014). The impacts of cannabis on road crash risk typically scale with the concentration of Δ^9-THC in the blood at the time of driving. For example, Drummer et al. found that the OR of being culpable for a crash was 2.7 for all drivers where Δ^9-THC was detected (and was the only intoxicating substance detected), with this excess risk rising to 6.6 where the concentration of Δ^9-THC in the blood exceeded 5 ng/mL (Drummer et al., 2003).

The tangible and intangible costs of premature mortality due to cannabis-attributable transport accidents are included in the broader estimates of premature mortality costs (see Chapter 3), and the impact on hospital separations and other medical costs arising from cannabis-attributable road crashes are included in Chapters 4 and 5 respectively, however the identification of cannabis-attributable road crashes is set out below. Quantification of the costs of other road crash related harms is also undertaken in this Chapter.

8.2 Road crash frequency

Road crashes can be a difficult area to quantify, as lower severity crashes do not have to be reported to police and so are generally underreported. There are also differences in the way in which transport crashes are classified between different jurisdictions; even for serious accidents states and territories used varied definitions of what constitutes a serious accident. The two reliable and consistent forms of data on road crash frequency (and transport accidents more broadly) are deaths arising from road crashes and hospital separations caused by road crashes.

The last comprehensive assessment of road crash frequency and costs, including quantification of accident frequency by severity, was undertaken by the Bureau of Infrastructure, Transport and Regional Economics (BITRE) in 2010 with a reference year of 2006 (Bureau of Infrastructure Transport and Regional Economics, 2009). BITRE estimated the total number of crashes in the reference year by applying estimates of the proportion of unreported crashed by severity to data provided by state and territory governments on the number of reported road crashes.

BITRE estimated that there was a total of 653,000 road crashes in 2006 involving 1.15 million vehicles. There were 1,602 deaths as a result of road crashes in 2006 with a further 31,204 persons admitted to hospital (Bureau of Infrastructure Transport and Regional Economics, 2009).

Table 8.1: Estimated number of road crashes resulting in injury by severity of injury, 2006

Crash outcome	Number of crashes	No. of persons injured by severity	No. of vehicles involved
Fatalities	1,455	1,602	1,886
Hospitalised	25,498	31,204	428,643 [a]
Not hospitalised injury	188,200	216,500	
Property damage only crashes	438,700	-	715,862
Total	**653,853**	**249,306**	**1,146,391**

Source: Bureau of Infrastructure Transport and Regional Economics, (2009) pp. 10, 13, 14.
[a] Data on the number of vehicles involved in collisions is not disaggregated by severity of injury.

Data on the number of fatal road crashes in 2015/16 were taken from the national road fatalities database (Bureau of Infrastructure Transport and Regional Economics, 2019). Data on hospital separations attributable to road crashes were sourced from an analysis of the AIHW NHMD (Chrzanowska, 2019, *personal communication*) (Table 8.2). More recent estimates are not available for the number of road crash accidents whose consequences are less severe than hospitalisation. We have assumed that the number of other accidents have increased by 17.5 percent, the same rate as land transport accident hospital separations over the period, which increased from 52,286 in 2005/06 (Pointer, 2018) to 61,454 in 2015/16 (Pointer, 2019). This rate of increase roughly reflects the increase in population over this period (Table 8.3) [32].

Table 8.2: Estimated road crash frequency by severity, 2015/16

Severity level	Estimated total crashes	Estimated total injuries	Cannabis-attributable crashes	Cannabis-attributable injuries
Fatalities	1,158	1,611	16.5	23.0
Hospitalised injuries	35,322	43,227	503.4	616.0
Not hospitalised injuries	221,212	254,476	3,152.3	3,626.4
Non-injury crashes	515,653	n/a	7,348.2	n/a

Sources: Bureau of Infrastructure Transport and Regional Economics, (2009) pp. 10, 13, 14; Chrzanowska, 2019, personal communication; Hall et al., 2019a; Hall et al., 2019b; Davey and Freeman, 2009; Drummer et al. 2003.

8.3 Cannabis-attribution

Attribution of transport crash harms to cannabis ideally requires an estimate of the RR of an accident when the driver is intoxicated with cannabis and the prevalence of cannabis intoxication amongst drivers. Unfortunately data on the extent and frequency of intoxication amongst drivers is limited and of generally poor quality (for example the proportion of positive drug tests in roadside drug tests by police are unlikely

[32] Over the same period ***road crash*** hospitalisations increased from 31,204 to 44,007; an increase of 44%. It is not clear why road crash hospitalisations increased at a much faster rate than overall transport accident hospitalisations; however as we cannot rule out changes in coding practices we have used the more conservative change in transport accidents rather than the change in road crashes.

to be representative of the overall population of drivers, as they are generally targeted at times of the day and areas in which it is thought that drug driving is more likely to occur). Also, as noted in Chapter 3, detection of Δ⁹-THC does not indicate the extent of impairment. Prevalence studies often ask respondents whether they have ever driven under the influence of intoxicating substances, but do not typically report on the frequency of this behaviour or, of course, degree of intoxication.

Two broad approaches are generally taken to identifying the proportion of road crashes attributable to a substance such as cannabis:

- Culpability analysis studies which use hospital records or coronial records to identify the proportion of accidents where the user of the substance was at-fault for the accident and whether the proportion that were at-fault exceeds the proportion of injured drivers testing positive for the substance; and,
- AF based approaches are where a series of studies are used to identify the RR of substance use prior to driving which is combined with data on the proportion of the population who consumes cannabis prior to driving to calculate the relevant AF.

Cannabis intoxication appears to be a common feature in serious road traffic accidents. For example, Drummer et al., in a study that examined 3,398 road crash fatalities in Victoria, NSW and WA over the period 1990-1999 (Drummer et al., 2003), found that 13.5 percent of drivers in road crash fatalities tested positive to cannabis, although only 8.5 percent of drivers tested positive to Δ^9-THC with the remainder testing positive to carboxy-THC a metabolite of Δ^9-THC which can be present in the blood for several days after consumption, which could mean that the driver was no longer impaired by cannabis at the time of the crash. Ch'ng and colleagues undertook analysis of a random sample of blood tests from drivers involved in serious injury crashes who presented at the ED of the Alfred Hospital in Melbourne, similarly found 7.6 percent of injured drivers tested positive to Δ^9-THC (Ch'ng et al., 2007) [33].

Many cost of illness studies make use of culpability analysis. This has a significant advantage in that the presence of the substance in question has been verified in a hospital setting and, as the accidents are more serious, culpability analyses undertaken by police accident investigators are available for the majority of cases. A limitation of this approach is that the calculation of the OR relies on the assumption that those intoxicated by substances were no more likely to be involved in a road crash than the broader population, just more likely to at-fault. If intoxication with the substance in question also increases the risk of being involved in a road crash as well as increasing the risk of being at-fault, then this approach will tend to underestimate the proportion of crash fatalities attributable to intoxication.

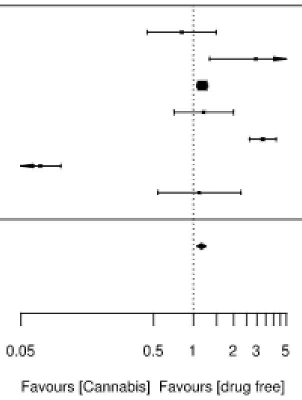
A pooled risk assessment of Australian culpability studies undertaken by the authors, indicated that the odds of a person being culpable of causing an accident after having consumed cannabis was 1.15 times the odds of a person being culpable of causing an accident while not under the influence of substances, and this result was statistically significant ($p = 0.001$). However, the included studies show a very wide variation in estimated results, with one study finding a statistically significant ***reduction*** in risk amongst those under the influence of cannabis, and the results of several other studies not meeting the traditional standard for statistical significance due to their broad CI.

[33] Concentration not reported: limit of detection >0.002 mg/L or 2 ng/mL.

Figure 8.1: Pooled risk of road crash culpability of cannabis users

Study	Cannabis Events	Cannabis Total	drug free Events	drug free Total	Weight	Odds Ratio IV, Fixed, 95% CI
Longo et. al 2000	21	44	996	1887	1.82%	0.82 [0.45, 1.49]
Drummer et. al. 2004	51	58	1214	1704	1.03%	2.94 [1.33, 6.52]
Dubois et. al. 2015	561	3387	12679	87280	76.12%	1.17 [1.06, 1.28]
Poulsen et. al. 2014	74	96	403	546	2.48%	1.19 [0.71, 1.99]
Laumon et. al. 2005	596	6766	85	3006	12.16%	3.32 [2.63, 4.18]
Martin et. al. 2017	35	325	2569	4059	5.13%	0.07 [0.05, 0.10]
Lowenstein et. al. 2001	17	34	114	240	1.26%	1.11 [0.54, 2.27]
Total (95% CI)		**10710**		**98722**	100.00%	1.15 [1.06, 1.25]

Heterogeneity: $\chi^2=324.13$, df=6 (P=0) $I^2=98$
Test for overall effect: Z=3.42 (P=0.001)



Note: in this context 'favours (drug free)' means that the odds ratio identifies a higher risk for those testing positive to cannabis; 'favours (Cannabis)' indicates that the odds ratio identifies a higher risk for those who test negative to cannabis.

The alternative approach to estimating the excess risk of cannabis intoxication for road crashes is to use the AF based approach, which requires both an estimate of the RR, and of the extent to which individuals drive whilst intoxicated by cannabis.

We used the estimated RR of road crash injuries where a person drove 1-3 hours subsequent to cannabis use calculated by Hall and colleagues (RR 1.37) (Hall et al., 2019a; Hall et al., 2019b).

Estimates of the prevalence of driving whilst intoxicated by cannabis are quite variable, reflecting differences in the way the data are calculated. Studies which rely on positive drug detections from police roadside drug tests often report relatively high prevalence of use (e.g. Chu and colleagues (2012) report detection of Δ9-THC in 42 percent of tested Victorian drivers; and Wundersitz & Konstad (2017) report detection rates of 17.8 percent in SA). However, these police activities do not represent a random sample, rather police typically target testing resources at locations and times of the day when they are more likely to detect drivers under the influence of alcohol and/or illicit drugs. For this study we have used the reported prevalence of drivers testing positive to cannabis in a random series of tests conducted in Queensland, which found 1.3 percent of drivers tested positive to Δ9-THC, with positive tests amongst 1.7 percent of male drivers and 0.5 percent of female drivers (Davey and Freeman, 2009).

Combining these two estimates gives an estimated AF of 0.017 for male drivers and 0.005 for female drivers. Weighting these by the relative likelihood for males and females to be the culpable driver in an accident (Drummer et al., 2003) gives a weighted AF of 0.014 (low bound 0.005, high bound 0.025). For this study we have used the RR approach. The estimated results by crash severity are shown in Table 8.2.

8.4 Costs of road crash accidents

There is a range of harms and costs that can arise from transport accidents including:

- Premature mortality;
- Hospital separations;
- Permanent disability;
- Non-hospitalised injuries;

- Damage to property; and,
- Costs of insurance administration.

The tangible and intangible costs of premature mortality due to cannabis-attributable transport accidents are included in the broader estimates of premature mortality costs (see Chapter 3). The impact on hospital separations and other medical costs arising from cannabis-attributable road crashes are included in Chapters 4 and 5 respectively. Quantification of the costs of other road crash related harms is undertaken in this Chapter.

There are two broad approaches that could be taken to estimating the impacts of long-term injuries and medical treatment resulting from road crashes: (1) calculating the costs of each specific form of harm individually (e.g. outpatient medical care, and where the injury was severe enough to result in long-term impairment, lost lifetime output in the workplace, lifetime value of lost household labour, modifications to dwellings and vehicles to adjust for impairment, and long-term care costs over the lifetime); or, (2) using compensation payments for injuries where long-term costs are 'capitalised' into a single lump sum payment in the study year.

The former approach will result in estimates that are consistent with the valuation of other forms of cost in this study (e.g. consistent valuation of workplace and household labour, of a quality adjusted life year QALY) and as such has much to recommend it. However, using the value of compensation payments has the advantages of avoiding any uncertainty of the expected years of life remaining after a road crash resulting in a severe impairment and giving a cost that is incurred entirely in the study year. This approach may, however, understate the intangible costs relative to society's willingness to pay to avoid them. Therefore, we will use the compensation payments approach to calculate the low bound of costs (Section 8.3.2.1), and the specific costs based approach to calculate the high bound (Section 8.3.2.2) and use the average of the two approaches as the central estimate.

8.4.1 Property damage caused by cannabis-attributable road crashes

The BITRE (2009) estimated that property damage resulting from road crashes cost Australia $4.2 billion in 2006. Converting this to 2015/16 values using the CPI (Australian Bureau of Statistics, 2019c) and dividing by the estimated number of road crashes in 2006, gives an estimated average property damage per road crash of $4,601.81 in 2015/16.

Our central estimate is that there were 11,020 cannabis-attributable road crashes in 2015/16 (low bound 4,126, high bound 17,160), giving an estimated cost of property damage of **$50.7 million** ($19.0 million to $79.0 million) (see summary Table 8.4).

The costs of insurance administration for claims related to road accidents were estimated by BITRE to be $257.5 million in 2006, with civil legal actions costing a further $231.3 million [34] (Bureau of Infrastructure Transport and Regional Economics, 2009). Combining these two cost items, converting them to 2015/16 values using the CPI (Australian Bureau of Statistics, 2019c), and dividing by the estimated number of road crashes in 2006 gives a per crash estimate of $945. Multiplying by the estimated number of cannabis-attributable road crashes gives a central estimate of insurance administration and legal costs of **$10.4 million** (low bound $3.3 million, high bound $13.7 million).

---

[34] These civil legal costs are not captured in Chapter 7.

Finally, BITRE (2009) estimated that road crash injuries created workplace disruption costs (including temporary replacement costs for temporarily impaired workers, and the costs of recruitment and training to replace those unable to return to their previous employment) to employers of $77.7 million in 2006. Converting this to 2015/16 values using the change in the CPI (Australian Bureau of Statistics, 2019c), and dividing by the estimated number of road crashes in 2006, gives an estimated average workplace disruption cost per road crash of $88 in 2015/16. Multiplying by the estimated number of cannabis-attributable road crashes gives a central estimate of the cost of workplace disruption to employers of **$0.9 million** (low bound $0.3 million, high bound $1.2 million).

8.4.2 Long-term costs of road crash injuries

We used two approaches in estimating the long-term costs of road crash injuries. These formed the low and high bounds of our estimate, with the mean of the two approaches being our central estimate of long-term costs.

8.4.2.1 Compensation paid approach (low bound estimate)

The low bound approach to estimating the long-term costs of road crash injuries makes use of compensation payments made by third party insurance providers. The Transport Accident Commission (the Victorian provider of third party injury insurance) paid out $1.2 billion in compensation in 2015/16 (Transport Accident Commission, 2016). Victoria on average accounted for 22 percent of road crash fatalities in 2015 and 2016 (Bureau of Infrastructure Transport and Regional Economics, 2017), which implies national costs of $5.6 billion.

Applying our central estimate of the proportion of road crashes attributable to cannabis gives an estimate of compensation awarded for long-term injuries arising from cannabis-attributable road crash costs of **$79.8million** (low bound $29.9million, high bound $124.3 million).

8.4.2.2 Long-term care costs approach (high bound estimate)

The BITRE (2009) estimated that serious injury road crashes will lead to some degree of permanent impairment in around 15 percent of cases, with the degree of permanent impairment varying significantly from 'profound limitations' (2.2% of serious injury accidents) to 'mild limitations' (4.9 % of serious injury accidents).

Applying these frequencies to the estimated 44,017 road crash hospital separations in 2015/16 suggests just over 6,500 persons would be expected to have an on-going impairment due to road crashes injuries. Average unit costs of disability by severity are taken from BITRE (2009) and these, updated to 2015/16 values using the CPI (Australian Bureau of Statistics, 2019c) are shown in Table 8.3.

Table 8.3: Estimated unit costs of equipment and care costs due to permanent impairment from road crash injuries, 2015/16

Severity of impairment	Equipment purchase & dwelling modification (one-off) $	Care costs (annual) $	Equipment maintenance (annual) $	On-going medical (annual) $
Profound limitations	49,966.1	271,591.2	1,169.4	7,136.8
Severe limitations	49,966.1	72,185.7	1,169.4	7,136.8
Moderate limitations	18,129.5	22,795.5	424.3	4,282.1
Mild limitations	9,064.7	0.0	212.2	2,569.2

Source: Bureau of Infrastructure Transport and Regional Economics, (2009), Australian Bureau of Statistics, 2019c.

These unit cost estimates were multiplied by the estimated number of impairments of the relevant severity from cannabis-attributable road crashes and, where costs extend into the future, discounted back to 2015/16 terms using the Australian Government's recommended discount rate of 7 percent. This gives a present value of equipment and care costs of **$92.1 million** (low bound $34.8 million, high bound $143.1 million). Table 8.4 includes the costs for each of these components: equipment, support workers and medical costs.

In addition to these costs relating to dealing specifically with the impairment arising from road crashes, disabilities also impact on the probability of employment. The extent of the impact on employment will vary depending on the severity of the impairment, and the extent to which the injured individual's form of employment (or skill set and aptitudes) are amenable to modification to adjust for the impairment. Estimates presented by BITRE suggest that the reduction in employment probability ranges from 95 percent for those with profound limitations to a 30 percent reduction in the probability of employment for those with mild limitations (Bureau of Infrastructure Transport and Regional Economics, 2019).

Data on the estimated age at the point of injury, expected years of working life for that age group and gender, and the estimated reduction in the probability of employment were used to develop estimates of the (discounted) years of working life lost due to impairment resulting from cannabis-attributable road crashes. The central estimate was a (discounted) loss of 498 years of expected working life (low bound 132, high bound 1,726). Using the same approach as in the premature mortality calculations, each discounted year of working life lost was valued at $139,697, giving a total impact of YLD to impairment of **$72.1 million** (low bound $19.1 million, high bound $79.6 million).

Permanent impairment also reduces the potential for individuals to contribute to unpaid household labour. It was assumed that the impact of impairment on the ability to contribute (unadjusted for labour force status) was used as the basis for the calculation, giving an estimated (discounted) number of years of household labour lost due to cannabis-attributable impairment of 1,297 years (low bound 453, high bound 1,731). This was valued following the same approach as was used for the premature mortality calculation, valuing each year of household chores at $19,685 for males and $35,146 for females. Applying this to the estimated (discounted) number of years of chores lost gives an estimated cost of **$19.6 million** (low bound $5.2 million, high bound $21.6 million).

8.4.2.3 Central estimate of long-term costs

The compensation paid approach gives a low bound estimate of these costs of $79.8 million (the central estimate of that approach). The calculation approach based on the disaggregated lifetime costs gives an upper bound of $183.8 million (the central estimate of that approach). Taking the mean of the two approaches gives a central estimate of long-term care costs of **$131.8 million**.

8.5 Conclusion

Cannabis use has a small, but meaningful impact on road crash risk. The evidence is strongest for use within 3 hours of having consumed cannabis, which is estimated to cause around 1.4 percent of road crashes (low bound 0.5%, high bound 2.2%).

The costs arising from premature deaths, and hospital separations, from road crashes attributable to cannabis use prior to driving are set out in Chapters 3 and 4 respectively. The other costs of cannabis-attributable road crashes are estimated to have cost society **$193.9 million** in 2015/16 (low bound $102.4 million, high bound $277.7 million). The most significant contribution to these costs comes from the long-term costs of impairment resulting from road crashes ($131.8 million) followed by the cost of property damage $50.7 million (Table 8.4).

Table 8.4: Cannabis-attributable road crash cost summary

Cost domains	Central estimate ($)	Low bound ($)	High bound ($)
Premature mortality	a	a	a
Hospital separations	b	b	b
Costs of property damage	50,713,758	18,988,695	78,968,535
Costs of insurance administration and legal costs	10,414,972	3,297,114	13,711,753
Costs of workplace disruption	935,433	296,134	1,231,537
Long-term costs (average of approaches)	131,822,786	79,826,513	183,819,058
Total road crash costs not included elsewhere	**193,886,949**	**102,408,456**	**277,730,883**

[a] Estimated in Chapter 3.
[b] Estimated in Chapter 4.
Note: In the text we also report the low and high bound estimates associated with the items that contribute to the long-term estimate. These are not included in Table 8.4.

8.6 Limitations

High-quality population survey data on the extent to which individuals drive within 3 hours of having consumed cannabis are not available. Also, it is not possible to identify the degree of impairment. This analysis has had to rely on data from a study of police roadside tests that sought to deliver them in a random manner, rather than target places or times of day that were regarded as more likely to result in a positive drug test.

Data on the costs of road accidents is now dated, being to a large extent based on 2006 data. Whilst these costs have been converted to 2015/16 values it may be that the costs of some of the individual cost items grew at a faster or slower rate than the overall CPI, in which case the overall costs may be under- or over-stated.

It is also not possible to identify the relative severity of cannabis-attributable road crashes and so our calculations have been undertaken on the assumption that cannabis consumption has an equal impact on road crashes of all levels of severity.

CHAPTER 9: TENTATIVE ESTIMATE OF HARMS TO RESIDENT OTHERS

Robert J. Tait & Steve Whetton

9.1 Background

Substance use can impact on the health and wellbeing of people other than those consuming the substance themselves, with subsequent costs arising from those harms. The literature has particularly focused on the harms arising from alcohol use by other people (Callinan et al., 2016; Laslett et al., 2011; Nayak et al., 2019) or on the health effects of exposure to tobacco smoke (US Department of Health and Human Services, 2006). With respect to illicit drugs, the literature is less extensive, although there are assessments of specific harms. For example, Nicosia and colleagues analysed the effect on the maltreatment of children by parents who chronically used methamphetamine or who engaged in home-based manufacture of methamphetamine. They estimated that about 9 percent of the young people taken into foster care were due to methamphetamine use, at a cost of USD 501.8 million in 2005 (Nicosia et al., 2009).

The impact on affected family members living with a person with a drug use disorder may include both tangible costs, such as theft from the household, or lost wages from caring for a sick family member and intangible costs (e.g. through reduced quality of life). Many of the issues impacting quality of life are likely to occur across different drug use disorders and may include: violence; emotional abuse; impaired mental wellbeing; increased ill-health; diminished family relationships; and, alienation from friends and the wider community (Orford et al., 2013; Orford, 2015). In cases involving illicit drug use disorders, there may be additional family concerns about: criminal activity; exposure to criminal networks; and, legal repercussions.

We emphasise that drug use disorders are not causal or necessarily predictive of child neglect, but that drug use and dependence are associated with increased risk of neglect and abuse after controlling for other characteristics, with the potential for long-term consequences for the young person (Chaffin et al., 1996; Leijdesdorff et al., 2017). Taylor et al. (2008) estimated that the cost of child abuse and neglect in Australia for 2007 was in the range $10.7 billion to $30.1 billion, with the lifetime cost being $13.7 billion to $38.7 billion for those first abused in 2007. The harms incurred by both adults and children are likely to be similar in terms of increased risk of distress and mental and physical health consequences, but there may also be unique harms for young people in terms of hurt, shame and embarrassment, early caring responsibilities, and in more severe cases, through family break-down (Arria et al., 2012; Orford, 2015). The costs associated with the child protection system are examined in Chapter 11: here the focus is on intangible costs.

The attempt to quantify the harms and costs to partners, children and concerned others, from illicit drug use is still in its early stage, and there do not yet appear to be an agreed set of parameters or measures used in their estimation (Birkeland et al., 2018; Whetton et al., 2020). Further, even determining the number of partners, other adults or children living with a person dependent on illicit drugs is subject to considerable uncertainly, without considering the broader range of people affected outside the household (Whetton et al., 2016). Finally, some of the intangible costs to those resident with a person who has a substance use disorder may be included in other cost calculations in this report, such as the estimated intangible cost to victims of crime, creating the potential for a degree of double counting if harms to others are included in the core cost calculations.

9.2 Number of people resident with a person dependent on cannabis

We used the GBD compare tool (Global Burden of Disease Collaborative Network, 2018) to estimate the number of people who were classified as dependent on cannabis (Table 2.2: 150,208 with a range of 117,736 to 188,240). The range was used in calculating the low and high bound for the costs. However, the GBD tool does not provide any information on the household structure for a person who is dependent on cannabis and so we could not directly estimate the number of co-resident partners and / or children.

The NDSHS (Australian Institute of Health and Welfare, 2017i) does include data on the household structure of respondents, but does not have a standard measure of drug dependence. However, it does collect information on the frequency of drug use, so we used 'daily' use of cannabis as a proxy measure for the characteristics of those with dependence (Table 2.3). Clearly, using cannabis on a daily basis does not necessarily equate to dependence: as shown in Table 2.3, there are 142,699 more people reporting daily use than were classified with cannabis dependence by the GBD. Nevertheless, there is likely to be a substantial overlap between these two populations. Given the difference in the number of cases and potential differences in the age and sex structure of the cohorts, before assessing the number of children and partners living with a person who was dependent on cannabis, we had to draw on the NDSHS data for estimates of household structure, but the estimated population of persons who are dependent on cannabis was from the GBD.

We standardised the NDSHS against the GBD results via a two-stage process. First, ten-year age-group and sex specific estimates of the average number of dependent children, the average number of resident partners, and the average total number of persons resident with a person who used cannabis daily were extracted from the NDSHS. Then these 'per person who used cannabis daily' averages were applied to the sex and ten-year age-group estimates of the total number of persons dependent on cannabis from the GBD. The number of children resident may be underestimated using this approach as the NDSHS records the number of children as 0, 1, 2, or 3+; we coded the latter category as 3 children.

On this basis, our central estimate was that there were about 46,000 children, 27,000 partners and 147,000 others who are living with a person dependent on cannabis (Table 9.1).

Table 9.1: Estimated number of persons co-resident with a person who is dependent on cannabis, 2015/16

Estimate of persons dependent on cannabis	Dependent children	Partners	Other co-residents
Central estimate	45,660	27,212	147,017
Low bound	36,478	21,143	112,733
High bound	57,539	34,342	187,427

Note: The NDSHS questionnaire defines dependent children as: "children aged 0 – 14, or older children who are still financially dependent, such as full-time students" (Australian Institute of Health and Welfare, 2017c, p3).

9.3 Quantifying the impact on household members

Once the size of the 'at-risk' population had been determined, we needed to quantify the extent of harms that they might incur. However, although it is generally acknowledged that those resident with a substance dependent person may incur harms (Birkeland et al., 2018; Orford et al., 2010), there is less consensus on how to quantify those harms and costs and these will very possibly vary by drug. One approach is to evaluate the potential reduction in their quality of life either in the form of DALY or QALY. As elsewhere in the current study we adopted the GBD approach and opted to use DALY.

Estimates have been made of the DALY lost due to substance use disorders, From the GBD, the unadjusted DALY for a person dependent on cannabis is 0.329 (Degenhardt et al., 2013b; Degenhardt et al., 2013c): as the severity of drug use disorders can vary over time, after adjustment to reflect asymptomatic periods, the revised figure used by the GBD was 0.162 DALY (Degenhardt et al., 2013b; Degenhardt et al., 2013c). The information on partners and children is less specific. A study in Spain found that the lost quality of life for those with alcohol dependence was 0.144 and for close family members 0.083 QALY (Nogueira and Rodríguez-Míguez, 2015). A review of the benefits gained from the treatment of alcohol disorders suggests that the benefits for family members are of a similar magnitude to the gains for the treated individual (Mortimer and Segal, 2006). However, an alternative estimate reported that the impact on a co-resident adult from the successful treatment of another's alcohol disorder was 0.108 QALY gained (Salize et al., 2013). An approximate conversion formula for QALY to DALY (Sassi, 2006), gives a value of 0.154 DALY for a 35-year old family member, which is approximately half the DALY arising from moderate alcohol dependence (0.388 DALY). Therefore, based on the GBD adjusted estimate, we constructed a low and high range of the quality of life impact for living with a person with cannabis dependence of 0.081 – 0.162 DALY (i.e. a range from 50% of the DALY lost from cannabis dependence to 100% of the DALY lost from dependence).

9.4 Intangible costs to family members

Once the number of DALY have been calculated, these then need to be converted to monetary values: a process that is subject to critical debate (Baker et al., 2010; Dolan, 2010; Donaldson et al., 2011; Miller and Hendrie, 2011). In some instances (e.g. Moore (2007), Nicosia et al., (2009)) the value of a DALY has been equated to the value of a VoSLY. This method has been recommened when conducting cost-benefit analyses (Abelson, 2008). The approach used in determining the VoSLY is based on that used in calculating the annual payment for an annuity of a given value, and on the expected average years of life for the individual (typically 40 years). The formula is,

$$VoSLY_{\mathrm{t=1}} = VoSL \times \frac{(1-(1+g)/(1+r))}{(1-(\frac{1+g}{1+r})^{years})}$$

Where:

VoSL = estimated value of a statistical life;

g = annual escalation factor for VoSLY, typically the long-run real growth rate in per capita GDP

r = the discount rate being used, in Australian studies this is usually a real annual rate of 7 percent; and,

years = assumed average years of life remaining at the time of the study for the sample used to derive the VoSL estimate.

However, this simple approach has been criticised in that the value of a life-year varies depending on many factors including: age; health state; expected years of life remaining; the ability to pay; and, the person's preference on the distribution of resources over their lifetime (Baker et al., 2010; Dolan, 2010; Donaldson et al., 2011). It is also not clear if the prospective expressed willingness to accept less years of life to avoid a particular health condition is accurate given the degree of adaption shown by those people with the health condition (Dolan, 2010).

An alternative approach to the estimation of DALY is via specific studies on the preferences of the population of interest. The disadvantages of this approach is that preference studies are costly and time consuming to conduct and they may result in 'bespoke' values largely driven by random variations in the sample selected rather than in the 'true' value of averting death or ill-health from that particular condition. Therefore, we adopted an estimate based on the VoSLY.

Our central estimate for the VoSL for 2015/16 was $4.6 million (Abelson, 2008). Based on this we then calculated the value of a *single year* of life and hence a VoSLY of $286,553. We also developed a plausible range based on: a) the implicit threshold value per DALY from PBS approvals of $45,000 (Community Affairs References Committee, 2015; Harris et al., 2008); and, b) a VoSLY of $841,393 derived from the VoSL used by the US Department of Transport (2015).

The NDSHS allows the number of other residents in addition to partners and children to be calculated. However, the extent of the impact on their quality of life from another's cannabis dependence may vary markedly depending on the nature of their relationship: for example, parents would arguably be more affected than house mates. The NDSHS data, does not include information on these relationships. We therefore decided to exclude other co-residents from our central estimate. These costs, using the low band DALY are included in Table 9.2 for completeness, but not added to the overall total cost of DALY for partners and children.

Table 9.2: Tentative estimate of harms to resident others. 2015/16

Relationship to person dependent on cannabis	DALY lost estimate	Central estimate (Abelson value, $286,553/ VoSLY) $	Low bound (Implicit PBS value $45,000/ VoSLY) $	High Bound (US DoT value $841,393/ VoSLY) $
Resident children	Low DALY 0.081	1,059,801,535	166,430,186	3,111,848,744
	High DALY 0.162	2,119,603,070	332,860,372	6,223,697,487
	Mean	1,589,702,303	249,645,279	4,667,773,116
Resident partners	Low DALY 0.081	631,605,274	99,186,668	1,854,554,853
	High DALY 0.162	1,263,210,549	198,373,337	3,709,109,705
	Mean	947,407,912	148,780,002	2,781,832,279
Total cost partners and children	**Sum of means**	**2,537,110,215**	**398,425,281**	**7,449,605,395**
Other persons resident [a]	Low DALY 0.081	3,412,388,833	535,878,171	10,019,647,596
Total cost including other co-residents		5,949,499,048	934,303,452	17,469,252,990

Sources: Compare Tool (Global Burden of Disease Collaborative Network, 2018) NDSHS (Australian Institute of Health and Welfare, 2017i).

[a] Co-resident costs are excluded from the calculations as the impact experienced from the dependent user is unknown and varies by type of co-resident.

DALY = disability adjusted life years: NDSHS = National Drug Strategy Household Survey: PBS = Pharmaceutical Benefits Scheme: US DoT = United States Department of Transportation: VoSLY = value of statistical life year.

Our estimate of the lost quality of life for dependent children and partner's resident with a person dependent on cannabis, was the sum of the two central values: **$2.5 billion** with a range of $0.4 billion to $7.5 billion.

9.5 Conclusions

The investigation of the impacts of substance use on others, has been dominated by studies on the harms arising from involuntary tobacco smoking (US Department of Health and Human Services, 2006) and alcohol (Callinan et al., 2016; Laslett et al., 2011; Nayak et al., 2019). The implementation version of the ICD (World Health Organization, 2018) includes harms to other people as one of the clinical criteria for substance use disorders. Therefore, we expect that there will be increased interest in this topic, but we are not aware of any previous attempts to estimate the cost of these harms for cannabis dependence. *Therefore, although these costs have been estimated, we have not included them in the overall total attributed to cannabis dependence*.

Our estimate focused on partners and children as these people are likely to be those most affected by another's cannabis dependence. We were unable to estimate the extent of the quality of life lost by parents and other adults co-resident with a person who is dependent on cannabis. The prevalence of dependence of cannabis means that a substantial number of children are exposed with the potential for enduring harms. We estimated that between 36,000 and 58,000 children were resident with a parent or guardian who was dependent on cannabis: there may be further children living with an adult who is dependent on cannabis but who are not financially dependent on that adult.

9.6 Limitations

We were unable to find any information on the comparative DALY lost for children versus partners for any substance use disorder, so we assumed that the extent of lost quality of life would be similar. Other than the study by Nogueira and colleagues (2015), we were not able to identify any studies that directly estimated the QALY or DALY lost as a result of living with a person dependent on a substance. We instead relied on studies that estimated the quality of life impact relative to the DALY lost for the people who used the substance (alcohol) themselves.

In Section 9.1 we noted that there may also be tangible costs of living with someone dependent on cannabis, for example, lost income from caring for a sick partner, but we were unable to quantify these costs. Nevertheless, informal care makes a substantial contribution to health care and hence savings to health budgets (Deloitte Access Economics, 2015; Saka et al., 2009). The value of informal care is estimated in Section 5.11, but this estimate relates to care provided for impairment resulting from an illness or disability attributable to cannabis, and not the cost care provided for the acute and chronic effects of dependence on cannabis.

Given the possibility of variation in the nature and severity of cannabis use on others, accuracy demands cannabis specific data. Also, as noted above, given that no information on the household structure of persons dependent on cannabis was available from the GBD study, we used data on the household structure of those persons who used cannabis daily as a proxy (NDSHS data). This rests on the assumption that the characteristics of the two populations, once controlled for age and gender, are similar. If the household characteristics of those who have been classified as dependent in the GBD data differ systematically from those who use cannabis daily in the NDSHS, then our estimates of affected partners and dependent children will be biased. Whether this would lead to a lower or a higher estimate is not known. Furthermore, couples are likely to have similar substance use behaviours (Kendler et al., 2018). The extent to which this will affect the partner's quality of life is unknown. Similarly, we were unable to quantify the impact on children of having one *versus* two parents' dependent on cannabis.

CHAPTER 10: INTERNALITIES

Steve Whetton & Robert J. Tait

10.1 Background

In general, social cost studies do not include costs or harms that arise from consumption on the basis that these adverse effects will have been included in the original consumption decision and then factored into the purchase price. As noted earlier, this rational approach to consumption (Becker and Murphy, 1988) appears to be less applicable to the consumption of substances with dependence potential than to other goods, particularly among those identified with substance use dependence.

If the rational model does not apply to these substances, then it is appropriate to include consumption costs by those with a dependence disorder in public policy decisions. As these costs are not strictly social costs, they are often termed "internalities" or "private costs" and these are the total costs that were not included in the original consumption decision. There are various approaches to the analysis of these costs. A report on the social costs of gambling, attempted to evaluate both the level of consumption and the associated harms that would occur if these people were not dependent (Productivity Commission, 1991). Others include all the costs borne by people who are dependent as internalities, but the costs of drugs consumed by those classified as non-dependent are excluded, given that it is less certain that the assumptions of the rational model are not applicable with these people.

Care must be used when estimating internalities to avoid potentially 'double counting' some costs. For example, the VoSL may include the potential loss of future earnings (Tilling et al., 2012) therefore either the VoSL or the lost lifetime earnings for a person with substance dependence should be included. Similarly, either DALY lost by people with drug dependence or harms that occur to the consumer and captured as internalities should be included, but not both (Degenhardt et al., 2013c; Pyne et al., 2008). Thus, we recommend the use of ***either*** the quality of life impact ***or*** the estimated internalities, plus the expenditure by those dependent on cannabis be used in estimating the total internalities, but also acknowledge that this approach may underestimate the full extent of the internalities. We opted to use the quality of life impact plus the cost of cannabis purchases.

10.2 Estimated quality of life impact of dependent cannabis use

To estimate the quality of life lost from dependence on cannabis we selected the DALY as our preferred measure. As reported in the GBD, the unadjusted DALY lost from cannabis dependence is 0.329 (Degenhardt et al., 2013b; Degenhardt et al., 2013c). However, as the level of severity of drug use disorders can vary over time, the GBD adjusted this value to reflect asymptomatic periods, giving a revised figure of 0.162 DALY (Degenhardt et al., 2013b; Degenhardt et al., 2013c).

Using the adjusted DALY of 0.162 and the estimate of 150,208 people dependent on cannabis in 2015/16 (Global Burden of Disease Collaborative Network, 2018), results in a total years of life lost to disability (YLD) due to cannabis dependence of 24,334 (see Table 10.1).

Table 10.1: Estimated total years of life lost to disability (YLD) due to cannabis dependence, 2015/16

Basis for estimate	YLD
Estimate of a lost DALY = 0.162 for dependent cannabis use: dependent cases = 150,208	24,334

Sources: (Degenhardt et al., 2013b; Degenhardt et al., 2013c; Global Burden of Disease Collaborative Network, 2018): DALY = disability adjusted life years: YLD = years life lost to disability.

The same approach to valuing the YLD was used as detailed in Section 9.4, with the same VoSL ($4.6 million). This was then annualised to give the same VoSLY ($286,553). We also used the same approach and method to derive the low and high bound values (respectively $45,000 and $841,393) (Community Affairs References Committee, 2015; Harris et al., 2008; US Department of Transportation, 2015). We then applied these values to the estimated YLD arising from dependence on cannabis (Table 10.1) which gave a central estimate of **$7.0 billion** (Table 10.2).

Table 10.2: Estimated cost of DALY lost due to the quality of life impact of cannabis dependence, 2015/16

Basis of VoSLY estimate	Abelson 2008 ($)	Implied PBS threshold ($)	US DoT ($)
Estimate of a lost DALY for cannabis dependence (0.162)	6,972,893,590	1,095,016,320	20,474,201,479

Source: (Degenhardt et al., 2013b; Degenhardt et al., 2013c).
DALY = disability adjusted life year: PBS = Pharmaceutical Benefits Scheme: US DoT = United States Department of Transport: VoSLY = value of a statistical life year

10.3 Cost of cannabis purchased by those with cannabis dependence

As detailed in Section 2.2.1, we believe that drug purchases by those with substance use dependence are unlikely to fulfil the assumption of the rational addiction model (Becker and Murphy, 1988) and that expenditure by these people are eligible for inclusion in a social cost analysis. We used the GBD estimate of 150,208 people meeting the criteria for cannabis dependence (Global Burden of Disease Collaborative Network, 2018). The average price of an ounce of cannabis in 2015 and 2016 reported by the Illicit Drug Reporting System surveys, ranged from $290 (hydroponic) to $240 (bush) or $20 per gram for either (Stafford and Breen, 2016). However, the Illicit Drug Reporting System only reports the number of cones or joints used, rather than the weight or cost of cannabis consumed. Instead, this information was obtained from Grigg et al (2015), where spending on cannabis was reported at a mean of $50 per week, with a median of $30 per week. We used these values for our low and high range calculations ($234.3 million and $390.5 million, respectively) with the midpoint being the central estimate (**$312.4 million)** (Table 10.3).

Table 10.3: Cannabis purchased by those with dependence, 2015/16

Drug	Central estimate ($)	Low bound ($)	High bound ($)
Cannabis	312,432,640	234,324,480	390,540,800

Source: Grigg et al (2015)

In estimating the spending on heroin we used the National Wastewater Monitoring Program (Australian Criminal Intelligence Commission, 2018) as an alternative approach to calculating consumption from self-reports. The self-report of heroin consumption totalled $2.6 billion whereas the estimate from wastewater was $1.4 billion (Whetton et al., 2020). Unfortunately, the wastewater program did not report on cannabis at this time [35], so this alternative approach was not available.

10.4 Conclusions

Most social cost studies do not include internal costs even for those classified with a substance use disorder. However, some analyses do include the cost of drug purchases (e.g. heroin (Jiang et al., 2017; Lin et al., 2013)), but we were unable to find any relating to the purchase of cannabis. We also did not identify any studies that have included the lost quality of life arising from drug dependence *per* se. *On this basis we decided to estimate and report these internal costs, but not include them in the overall figure attributed to cannabis dependence*. Our estimate of the overall internal costs arising from drug purchases and the reduced quality of life for persons dependent on cannabis was **$7.3 billion** (Table 10.4).

Table 10.4: Summary of internalities for those with cannabis dependence

Component	Central estimate ($)	Low bound ($)	High bound ($)
Value of DALY lost	6,972,893,590	1,095,016,320	20,474,201,479
Cannabis purchases	312,432,640	234,324,480	390,540,800
Total	**7,285,326,230**	**1,329,340,800**	**20,864,742,279**

DALY = disability adjusted life year.

10.5 Limitations

In Section 10.3 we noted that estimates of the cost of (heroin) drug purchases extrapolated from self-reported frequency and quantity of use differ markedly from estimates derived from wastewater analysis (Whetton et al., 2020). In this analysis we used a direct estimate of spending on cannabis, which may or may not be subject to the same potential error. However, we do note that the sample analysed by Grigg et al., (2015) who reported their cannabis expenditure, comprised 40 percent who used ‘daily’ and 41 percent who used ‘at least weekly but not daily’, so their consumption is possibly lower than that of people who are dependent on cannabis. In addition, some people may grow cannabis that would also involve some expense, which was not included in our calculation.

[35] Cannabis was added in 2018 https://www.acic.gov.au/sites/default/files/2019/02/ww6_300119.pdf?v=1561684377

CHAPTER 11: MISCELLANEOUS COSTS

Steve Whetton & Robert J. Tait

11.1 Child maltreatment and protection

11.1.1 Background

We estimated the costs arising from premature death and hospital episodes in Chapters 3 and 4 with the potential reduced quality of life from being co-resident with a parent with cannabis dependence reported in Chapter 9. As a further separate cost, we estimated the contribution of cannabis consumption to childhood neglect and child protection. Firstly, it should be noted that legal definitions and the associated systems will vary by jurisdiction but similarities remain in the stages between initial notification to child protection and outcomes (Bromfield and Higgins, 2005). Secondly, we emphasise the multifactorial nature of child protection cases and that removal of a single factor, such as drug use, would not necessarily prevent the death or harm of an individual child (Field, 2016).

11.1.2 Number of child protection cases

Quantification of the relevant cases is subject to considerable uncertainly with limited public data available on the underlying cause(s) for substantiated child protection orders, other than the broad categories of “physical”, “sexual”, “emotional” and “neglect” (Australian Institute of Health and Welfare, 2016a). A detailed analysis of cases in Victoria, by Laslett and colleagues (2013), examined 38,511 substantiated cases. From these, 13,579 (35.3%) included a parental history of “substance abuse” of which 6,119 (15.9%) involved drug use only and 7,462 (19.4%) documented alcohol and drug use (Laslett et al., 2013).

Across Australia in 2015/16 there were 45,714 young people (aged 0-17 years) with substantiated cases (Steering Committee for the Review of Government Service Provision, 2017a). If we extrapolate the Victorian data (15.9% and 19.4%) to the national figures, there would be 7,269 “drug use” cases and 8,869 “drug and alcohol” cases in 2015/16. To attribute a proportion of these cases to cannabis, we used the proportion of closed treatment episodes for people receiving treatment for cannabis (Australian Institute of Health and Welfare, 2017g). There were 45,099 episodes where cannabis was the primary drug of concern, with a further 39,344 episodes where it was an additional drug of concern (Australian Institute of Health and Welfare, 2017g).

Of the total episodes of care for their own drug use (198,747) in 2015/16, 22.7 percent were primarily for cannabis use: of the 153,271 episodes that involved additional drugs of concern, 25.7 percent involved cannabis. On this basis we allocated 1,649.5 instances of the substantiated “drug use only” cases to cannabis use and 2,276.6 instances of the “drugs and alcohol” substantiated cases. From the total of 45,714 substantiated cases, cannabis use therefore accounted for 3,926.1 (8.6%) instances.

As with the analysis of extra-medical opioid related costs (Whetton et al., 2020), we also used a second approach to estimating the impact of cannabis use on the number of child protection cases. This method was based on a detailed review of 467 cases representing children at their first entry into the South Australian care system (Jeffreys et al., 2009). The study’s findings reported that 70.2 percent (n = 328) of cases involved parental substance use. A detailed case series of 99 randomly selected out of the original sample revealed that 75 (75.8%) involved substance use, with 40 cases (53.3%) mainly involving cannabis.

Table 11.1: Factors influencing decision to take a child into care in South Australia for the first time by whether substance use was noted in the case file, 2006

Factor influencing decision to take into care	Substance use: No [a] % with factor	Substance use: Yes [b] % with factor	Substance use: No [a] # of times with factor	Substance use: Yes [b] # of times with factor	All cases # of times with factor	All cases % of total factors
Alcohol use	-	77.3	-	253.5	253.5	11.1
Cannabis use	-	53.3	-	174.8	174.8	7.6
Amphetamine use	-	50.7	-	166.3	166.3	7.3
Heroin use	-	12.0	-	39.4	39.4	1.7
Prescription drug use	-	10.7	-	35.1	35.1	1.5
Intravenous substance use	-	4.0	-	13.1	13.1	0.6
Methadone use	-	2.7	-	8.9	8.9	0.4
Ecstasy use	-	1.3	-	4.3	4.3	0.2
Inhalant use	-	1.3	-	4.3	4.3	0.2
Parental mental health	54.2	65.3	75.3	214.2	289.5	12.7
Domestic violence	16.7	69.3	23.2	227.3	250.5	11.0
Homelessness	8.3	28.0	11.5	91.8	103.4	4.5
Financial difficulties	0.0	29.3	0.0	96.1	96.1	4.2
Parental incarceration	4.2	25.3	5.8	83.0	88.8	3.9
Housing instability	8.3	24.0	11.5	78.7	90.3	3.9
Transience	0.0	22.7	0.0	74.5	74.5	3.3
Criminal activity	0.0	20.0	0.0	65.6	65.6	2.9
Abandonment	4.2	17.3	5.8	56.7	62.6	2.7
Social isolation	20.8	12.0	28.9	39.4	68.3	3.0
Parent abused as a child	0.0	13.3	0.0	43.6	43.6	1.9
Family breakdown	12.5	13.3	17.4	43.6	61.0	2.7
Parental intellectual disability	25.0	2.7	34.8	8.9	43.6	1.9
Child behaviours	16.7	4.0	23.2	13.1	36.3	1.6
Parent/child conflict	16.7	4.0	23.2	13.1	36.3	1.6
Parent hospitalisation	12.5	4.0	17.4	13.1	30.5	1.3
Other jurisdiction CP involvement	4.2	4.0	5.8	13.1	19.0	0.8
Parent ex-GOM	12.5	1.3	17.4	4.3	21.6	0.9
Young parents	8.3	2.7	11.5	8.9	20.4	0.9
Parental death	0.0	4.0	0.0	13.1	13.1	0.6
Adolescent at risk	4.2	1.3	5.8	4.3	10.1	0.4
New arrivals	4.2	1.3	5.8	4.3	10.1	0.4
Support to relative carers	4.2	1.3	5.8	4.3	10.1	0.4
Unaccompanied minor, refugee program	8.0	0.0	11.1	0.0	11.1	0.5
Child disability	4.2	1.3	5.8	4.3	10.1	0.4
Child mental health	0.0	1.3	0.0	4.3	4.3	0.2
Child intellectual disability	0.0	1.0	0.0	3.3	3.3	0.1
Previous CP history	4.2	0.0	5.8	0.0	5.8	0.3
Recovery order	4.2	0.0	5.8	0.0	5.8	0.3
Total number of factors					**2,285.4**	**100.0**

Source: (Jeffreys et al., 2009), calculations by the authors.
[a] 139 cases.
[b] 328 cases.
CP = child protection: GOM = Guardianship of the Minister

The case review identified all factors mentioned in the case file as having contributed to the decision to place the child in care for both those with and without substance use factors (Jeffreys et al., 2009). No weighting or precedence of the factors could be identified. If it is assumed that each of the factors contributed an equal weight to the decision to take the child into care, and that none of the factors were caused by another factor, then the share of total factors can be used to identify the role of cannabis in care decisions.

Weighted up to the whole sample, there were an estimated 174.9 cases in which cannabis use was one of the factors contributing to the removal of a child into care for the first time, out of a total of 2,285.4 factors identified in the case review. Thus, cannabis use accounted for 7.65 percent of all factors identified in the care decision (see Table 11.1). On the assumption that each factor in the decision carried an equal weight, this suggests that 7.65 percent of the decisions to take a child into care could be attributed to cannabis use.

11.1.3 Child protection costs

From the Steering Committee for the Review of Government Services (2017a), in 2015/16, child protection services cost $4.8 billion. Using the treatment data with the analysis by Laslett and colleagues (2013) to determine the proportion of "drug use only" and "drug and alcohol" substantiated cases due to cannabis use (8.59%) equates to $408.6 million. The second method of identifying the total share of cannabis use among the factors identified in the South Australian case review suggested cannabis use accounted for 7.65 percent or $364.2 million. For the purpose of this report, we use the mid-point as our central estimate: **$386.4 million** (see summary Table 11.7).

11.2 Child Death Reviews

We assessed the role and associated costs of cannabis use in premature deaths in Chapter 3. However, there are additional costs associated with assessing some specific childhood deaths. In WA, the Ombudsman's annual report includes an estimate of the cost of conducting an investigation into any death that fulfil the criteria for a child death review: the Ombudsman does not investigate all such deaths. The average cost in 2015/16 was $18,597 per review over 41 investigations. While not asserting causality, between 2009 and 2016, on average 33 percent of cases involve drug use as a contributory factor although no specific drug categories were identified. As a separate category, 'alcohol use' was a factor in 37 percent of cases. (Field, 2016). We also note that the identification of 'drug use' in a report maybe by the victim, the perpetrator or others.

To allocate a proportion of the drug involved cases to cannabis use, we used the proportion of episodes where cannabis was the principal drug of concern (35.4%) in illicit drug treatment episodes as a proxy measure [36] (Australian Institute of Health and Welfare, 2017g. Table SD1). Assuming that this figure translates to WA, then 35.4 percent of cases equates to 14.5 deaths where cannabis use was potentially a contributory factor.

In each jurisdiction, child death reviews are investigated by the relevant state or territory authorities, and hence there are variations in the deaths that are reviewed. While reports from other jurisdictions identify drug use as a contributory factor, such as in unintentional overdoses, suicides, vehicle accidents and neglect (McMillan, 2017), the proportion of deaths where drug use was a contributory factor were not reported. Therefore, we used the estimate from WA (33%) in projecting the number of deaths likely to involve drug use and the treatment data in attributing a fraction of these to cannabis (35.4%) (Australian Institute of Health and Welfare, 2017g. Table SD1).

We identified 225.5 deaths in 2015/16 or the most recent available year that were either explicitly subject to detailed review (New South Wales, Western Australia) or where the young person was known to the child protection system and thus likely to be reviewed (Table 11.2). Extrapolating from the Western

[36] Primary drug of concern, excluding alcohol (63,270) and nicotine (4,688) episodes = 130,789 illicit drug episodes

Australian cost, this equates to $4.2 million in review costs in addition to any coronial or police investigations that were required. Using the 34.5 percent from the paragraph above as the proportion involving cannabis, the cost of conducting these child death reviews was **$1.5 million** (Table 11.7: no separate high and low bounds estimated)**.** As discussed in the limitations (Section 11.7), we did not add any further 'cases' to the number of deaths reported in Chapter 3 from this section of the analysis.

Table 11.2: Child protection deaths

State or Territory	Source	Reviewable deaths	Year
New South Wales	1	[a] 47.5	2014-2015
Queensland	2	[b] 46	2015/16
South Australia	3	[b, c] 24.6	2014-16
Tasmania	4	[d] 16	2015-2016
Victoria	5	[b] 38	2015/16
Western Australia	6	41	2015/16
Australian Capital Territory	7	[e] 0	2014/15
Northern Territory	8	[b] 12.4	2015
Total		**225.5**	

Sources: 1 = (McMillan, 2017); 2 = (Vardon, 2016); 3 = (Eszenyi, 2017); 4 = (Council of Obstetric and Paediatric Mortality and Morbidity, 2017, 2018); 5 = (Victorian Government, 2016); 6 = (Field, 2016); 7 = (Gregory, 2015) 8 = (Gwynne, 2016)

[a] 95 deaths in 2014 to 2015.

[b] Known to the child protection system.

[c] Mean of 2014 to 2016.

[d] Mean paediatric mortality 2015 to 2016.

[e] None of the deaths was known to ACT Children and Youth Protection Services.

11.3 Prevention programs

11.3.1 Cost of school prevention programs

Drug prevention programs are often sub-divided into primary prevention programs that attempt to prevent the people from commencing drug use and secondary prevention programs that aim to prevent the transition to more serious substance use. The former are typically delivered through schools, while the latter can either be delivered through schools or the broader community. A previous estimate found that Australia spent $156.8 million in 2009/10 on drug prevention programs, of which $79.2 million (50.5%) was spent as part of school based programs (Ritter et al., 2013). It was estimated that 25 percent of drug education was on illicit drugs for those in year eight and below while for older students, the estimate was 50 percent of these classes (Ritter et al., 2013). Overall, Ritter et al (2013) reported that these represent 0.2 percent of school hours and hence 0.2 percent of the recurrent expenditure ($79.2 million for 2009/10).

To update these estimates, we retained the approach used by Ritter et al (2013) that calculated the fraction of time that students spent on illicit drug prevention education and applied that to total government spending on school education. In 2015/16 federal and other government recurrent expenditure on schools was approximately $55.7 billion (Steering Committee for the Review of Government Service Provision, 2018c). Using the fraction identified above (0.2%), this equated to $113.3 million for illicit drug education. However, in primary schools illicit drug education focuses mainly on cannabis and steroids with secondary schools covering a broad range of illicit drugs (Auditor General Victoria, 2003). Therefore, we separately calculated the time and cost components for primary and secondary students.

Table 11.3: Estimated hours of illicit drug education and illicit drug costs for students in 2015/16

Estimate	Total student time on drug education (hours)	Share of drug education out of total hours [a]	Implied government spending on drug education ($) [b,c]	Spending on cannabis-related education ($)
		Secondary students		
Central estimate	8,041,121	0.42	101,615,987	20,323,197
Low bound	5,680,792	0.30	71,788,408	14,357,682
High bound	10,401,450	0.54	131,443,565	26,288,713
		Primary students		
Central estimate [d]	12,926,712	0.50	114,576,565	57,249,701

[a] Based on 1200 hours per year per student:

[b] (Steering Committee for the Review of Government Service Provision, 2018c)

[c] Non-Government schools: cost for any student, not just per secondary school student

[d] no range reported

The ABS reports that in 2015/16 there were 1.6 million full-time equivalent secondary students in government and non-government schools (Australian Bureau of Statistics, 2017d) with total spending of $24.3 billion (Steering Committee for the Review of Government Service Provision, 2018c). The estimated total school hours was based on a 1,200 hours per student (6 hour day and 40 weeks per year) was 1.92 million hours). Secondary student drug education hours per year (mid-point 10.05 hours per student, range 7.1 to 13.0 hours) were obtained from the Auditor General's (2003) report and multiplied by the number of students per year (Australian Bureau of Statistics, 2017d) and reduced by 50 percent to reflect the hours of illicit drug education. The 8.0 million hours on illicit drugs equate to 0.42 percent of total hours and hence a total cost for secondary illicit drug education of $101.6 million. The low and high bounds were estimated from the range of hours reported by the Auditor General (Auditor General Victoria, 2003) of 7.1 to 13.0 hours, which equated to 0.30 percent to 0.54 percent of hours and hence costs of $71.8 million to $131.4 million.

The Auditor General's report identified five broad classes of illicit drugs usually included in secondary school programs, (Auditor General Victoria, 2003). We were unable to locate the time allocated to each drug and have thus assumed that these are approximately equal. On this basis, the cost of cannabis prevention activities in secondary schools was estimated at **$20.3 million (range $14.4-$26.3 million)**.

For primary school students, the cost per student in government schools was $15,262 and $10,147 for non-government schools. The mean drug education time was 12 hours (no range reported): typically addressing alcohol, tobacco, steroids and cannabis. Thus, we allocated 3 hours to cannabis-related education. The total illicit drug education time was 12.9 million hours at an estimated cost of $114.6 million of which we allocated **$57.3 million** to cannabis. Table 11.4 shows the overall estimated costs of cannabis prevention in schools as **$77.6 million**.

Table 11.4: Cost of school cannabis prevention programs

School level	Central estimate ($)	Low bound ($)	High bound ($)
Primary	57,249,701	[a]	[a]
Secondary	20,323,197	14,357,682	26,288,713
Total	**77,572,898**	**71,607,382**	**83,538,413**

[a] Central estimate used for low and high bound values.

11.3.2 Cost of general population prevention programs

In addition to prevention programs delivered via schools, there are also prevention programs that target the general population. Ritter and colleagues (2013) assessed that in 2009/10, $77.6 million was spent on population-targeted illicit drug programs, with this total including direct costs, staff salaries and overheads. The cost comprised: $53.7 million from federal, state or territory governments: $18.9 million via the National Illicit Drug Strategy; and, $5.0 million on specific Indigenous programs under the Closing the Gap strategy (Ritter et al., 2013). However, it is now not possible to disaggregate the cost component, so an alternative approach was adopted.

WA reports the level of spending on prevention programs on a per capita basis: in 2015/16 this equated to $4.67 per person aged 14 and above, (Mental Health Commission, 2016). With a population of 2.08 million people aged 14 or older (Australian Bureau of Statistics, 2018b), this totalled to $9.7 million. However, these prevention programs covered both licit and illicit drugs with no sub-components reported. Unfortunately, we did not find equivalent costs for any of the other Australian jurisdictions and thus had to extrapolate the per person cost from WA to the overall Australian population of those aged 14 and above. In 2015/16 this equated to 9,749,225 people and hence a cost of prevention programs of $45.5 million. We used the assumption of Ritter and colleagues that 50 percent of prevention programs would target illicit drugs ($22.8 million), and of this we allocated one fifth to cannabis prevention activities: **$4.5 million** (Table 11.7: no separate high and low bound estimated).

11.4 Commonwealth government programs

The Alcohol and Other Drug Treatment Services in Australia are funded from various sources: the states and territory governments contribute about 49 percent; the Commonwealth government about 31 percent: and, the remaining 20 percent is funded by individuals or philanthropy (Ritter et al., 2014). We address other aspects of Commonwealth funding elsewhere (e.g. public hospitals, PBS, Medicare): this section considers Commonwealth funding of non-government organisations to provide services. It has previously been estimated that in 2012/13 this support totalled $129 million and was provided via the Non-Government Organisation Treatment Grants Program and the Substance Misuse Service Delivery Grants Fund (Ritter et al., 2014). However, the *New Horizons* review commented on the difficulty in identifying spending on these programs and services from publicly available documents, including from budget statements (Ritter et al., 2014).

Because of this difficulty, we used a bottom up approach as reported in Section 5.6. Nevertheless, there were two significant announcements of potentially relevant funding in 2015/16. In early 2015, $87 million was allocated for non-government agencies for the 2015/16 financial year under the Substance Misuse Service Delivery Grants Fund and the Non-Government Organisation Treatment Grants Program (Nash, 2015). These funds were then amalgamated into the Drug and Alcohol Program (personal communication Prevention and Treatment Section, Alcohol, Tobacco and Other Drugs Branch, September 2019). Further funding announced in late 2015 provided $300 million for a four-year period (Turnbull et al., 2015) and was provided in response to the National Ice Taskforce's Final Report, and committed for treatment, workforce support, prevention and education and community engagement. These latter funds were for distribution through the Primary Health Networks in the planning and commissioning of drug and alcohol treatment services (personal communication Prevention and Treatment Section, Alcohol, Tobacco and Other Drugs Branch, September 2019). However, as this commenced from 1 July 2016 it is outside the target year of this report. To avoid the potential for double counting, the tranche of funding announced in early 2015 (Nash, 2015) is not added to this section, with treatment services costed in Section 5.6.

11.5 Intangible costs of cannabis-attributable ill-health

11.5.1 Background

In addition to the tangible costs, some of the health problems attributable to cannabis, and the long-term consequences of cannabis-attributable injuries, also reduce the quality of life of those experiencing them. Some of these intangible costs of ill-health are quantified elsewhere in the report. The intangible impacts of road crash injuries are included in the cost calculations for cannabis-attributable road crash accidents set out in Chapter 8. The intangible costs to victims of crime, including the intangible costs of violent crime, are included in the cost calculations set out in Chapter 7. Finally, the intangible cost of arising from cannabis dependence itself is assessed in Section 10.2 and as such three cost areas are excluded from the calculations below.

As discussed in Section 9.3, quality of life impacts due to ill-health are typically quantified through one of two measures of the number of health adjusted YLL to a condition, either a DALY or a QALY. Consistent with the other sections of this report, the intangible impacts of ill-health have been measured in DALY, and specifically, as we are measuring reduced quality of life rather than reduced length of life, the intangible impact is YLD.

11.5.2 Method

There is considerable debate as to the best approach to expressing YLD (and DALY more generally) in monetary terms. Some authors recommend a straightforward conversion of a VoSL to a VoSLY by annualising it from an assumed average number of years of life yet to be lived (Abelson, 2008; Moore, 2007; Nicosia et al., 2009). Alternatively, a context specific adaption from a VoSL, accounting for current health states and expected future health states can be conducted or a VoSLY can be calculated based on information specific to the context of the particular study through a discrete choice survey of the relevant population (Baker et al., 2010; Dolan, 2010; Donaldson et al., 2011; Miller and Hendrie, 2011), see Section 9.3 for a more extensive discussion.

Adopting the approach used elsewhere in the report, we used a value for a DALY based on the VoSLY derived from a VoSL. Our central estimate is based on the Abelson estimate of the VoSL ($3-4 million in 2007 values, Abelson (2008), converted to 2015/16 values using the change in the average nominal national per capita income over that period, and then converted to a value of a life year (again see Section 9.2 for the approach taken to the annualisation). Our high bound estimate of the VoSLY was derived from the VoSL used by the US Department of Transport (2015) and the low bound value per DALY lost was based on the implicit threshold value per DALY used for PBS approval ($45,000 in 2014/15 values) (Community Affairs References Committee, 2015; Harris et al., 2008).

The number of YLD for each partially cannabis-attributable condition was sourced from the GBD Study 2017 (Institute for Health Metrics and Evaluation, 2019). Information was extracted by condition, gender and broad age groups for persons aged 15 years and older. The GBD reports by calendar year and so a mean value was taken of the 2015 and 2016 estimates. In contrast to the approach taken elsewhere in this report, data on YLD is only available based on the total burden experienced in the year in question (e.g. as a stock measure). It is not possible to identify the extent to which these harms were first experienced in the study period, or whether they represent long-term quality of life loss from harms that occurred in previous years.

The source of the RR estimates used to identify what proportion of the intangible cost should be attributed to cannabis is the same as for the mortality and hospital separation calculations (see Table 2.1). However, not all conditions identified as at least partially caused or prevented by cannabis were individually identifiable in the GBD data, largely due to aggregation issues. The following conditions that are included in our hospital separations cost calculation were **excluded** from the YLD calculation due to data unavailability:

- Chronic bronchitis; and,
- Cannabinoid hyperemesis syndrome.

As noted above, intangible costs arising from interpersonal violence and road crash injuries were excluded from this calculation as they have already been quantified in their respective sections, as was the cost of cannabis dependence which is assessed in Chapter 10. Thus, data were only available for ‘schizophrenia and other psychosis outcomes’ and ‘depressive disorders’.

11.5.3 Results

Estimates of the impact on quality of life of cannabis-attributable ill-health where it could be quantified are set out in Table 11.5, expressed in total YLD attributable to cannabis by gender and broad age group.

Amongst those conditions that could be quantified, the total impact of cannabis-attributable ill-health was 4078.7 YLD (low bound: 1721.2 YLD, high bound: 8166.3 YLD). Sixty-two percent of the intangible cost was borne by males, and 82 percent was borne by those men and women aged 15 to 49 years.

Converting these YLD estimates to monetary values gives an estimate of the intangible cost of cannabis-attributable illness of **$1.2 billion** using the Abelson (2008) values of a statistical life year (low bound: $0.5 billion; high bound $2.3 billion) (Table 11.6).

Table 11.5: Years lost due to disability from cannabis-attributable ill-health, 2015/16

Condition	Age group (years)	Male			Female		
		Central estimate	Low bound	High bound	Central estimate	Low bound	High bound
Schizophrenia and other psychosis outcomes	*15-49*	1332.7	629.8	2503.9	628.8	299.9	1152.3
	50-69	326.0	153.2	608.3	138.5	63.4	259.3
	70+	6.3	2.9	12.1	1.0	0.5	2.0
Depressive disorders	*15-49*	732.9	173.6	1850.5	628.8	299.9	1152.3
	50-69	139.0	32.9	351.3	138.5	63.4	259.3
	70+	5.1	1.2	13.0	1.0	0.5	2.0
Total cannabis-attributable ill-health	**15-49**	2065.6	803.4	4354.5	1257.7	599.9	2304.7
	50-69	465.0	186.0	959.6	277.0	126.9	518.6
	70+	11.3	4.1	25.0	2.0	0.9	3.9
	All aged 15+	**2541.9**	**993.5**	**5339.1**	**1536.8**	**727.7**	**2827.2**

Source: YLD data, [Institute for Health Metrics and Evaluation (2019), Global Burden of Disease 2017, GBD Compare Tool, https://vizhub.healthdata.org/gbd-compare/, data extracted 9 April 2019. Share of harm attributable to cannabis calculated from relative risks set out in Table 2.1.
YLD = years of life lost to disability

Alternatively, if the VoSLY implied by PBS decision criteria is used, the cost of cannabis-attributable ill-health is $0.2 billion (low bound: $0.1 billion, high bound $0.4 billion) (Community Affairs References Committee, 2015; Harris et al., 2008). Using the VoSLY from the US Department of Transport (2015) gives an estimated cost of $3.4 billion (low bound $1.5 billion; high bound: $6.9 billion).

Table 11.6: Monetary value of years lived with disability due to cannabis-attributable ill-health, 2015/16

Condition	Central estimate $	Low bound $	High bound $
VoSLY from Abelson 2008 ($286,553)			
Schizophrenia	697,266,387	329,432,350	1,300,354,118
Depressive disorders	471,489,156	163,775,492	1,039,726,166
Total intangible costs of cannabis-attributable ill-health	**1,168,755,544**	**493,207,842**	**2,340,080,284**
VoSLY derived from PBS criteria ($45,000)			
Schizophrenia	109,498,025	51,733,731	204,206,326
Depressive disorders	74,042,191	25,719,141	163,277,570
Total intangible costs of cannabis-attributable ill-health	**183,540,216**	**77,452,872**	**367,483,896**
VoSLY from US DoT ($841,393)			
Schizophrenia	2,047,352,697	967,297,755	3,818,172,737
Depressive disorders	1,384,412,921	480,886,790	3,052,902,319
Total intangible costs of cannabis-attributable ill-health	**3,431,765,619**	**1,448,184,545**	**6,871,075,056**

Source: YLD data, [Institute for Health Metrics and Evaluation (2019), Global Burden of Disease 2017, GBD Compare Tool, https://vizhub.healthdata.org/gbd-compare/, data extracted 9 April 2019. Share of harm attributable to cannabis calculated from relative risks in Table 2.1.
YLD = years of life lost to disability: VoSLY = value of a statistical life year: US DoT = United States Department of Transportation.

11.6 Conclusions

This Chapter identified cannabis-related costs across a diversity of domains with, at times, little information available to determine the number of eligible events or relevant costs contributing to the overall total (Table 11.7). Nevertheless, in each case it is clear that there are costs even when it is difficult to reliably quantify them. We particularly note the difficulty of ascribing costs within the child protection system or in attributing harms to a specific substance in the presence of multiple adverse social factors. Further, although substantiated child protection cases are likely to identify the most severe instances of harm, this approach will not identify all harms or even all cases of severe harm.

The intangible costs of ill-health were not included in the last national estimate of drug-related costs (Collins and Lapsley, 2008) and, at $1.2 billion represents a significant source of substance attributable costs, despite the fact that the YLD from a number of sources of cannabis-attributable ill-health could not be quantified. Therefore, improved availability of data may well increase the estimate of intangible costs in future analyses.

It is open to question whether these costs of cannabis-attributable ill-health should be included in a social cost analysis as they impact the substance user themselves and will only partially arise as a result of dependence. To the extent that these costs are incurred by persons who are not dependent on cannabis, and where the persons using cannabis could possibly be expected to know that schizophrenia and depression are potential risks arising from cannabis use, then these intangible costs are purely internal and should not be included in the social cost.

For this reason, whilst the intangible costs of cannabis-attributable ill health are reported in this Chapter, they are not included in the overall social cost estimates.

Table 11.7: Summary Chapter 11 costs

Cost area	Central estimate ($)	Low bound ($)	High bound($)
Child protection cases	386,407,212	364,188,023	408,626,402
Child death reviews	1,446,800	[a]	[b]
School prevention programs	77,572,898	71,607,382	83,538,413
General prevention programs	4,552,888	[a]	[b]
Federal government programs [c]	-	-	-
Intangibles	1,168,755,544	493,207,842	2,340,080,284
Total	**469,979,798**	**441,795,093**	**498,164,503**

[a] Low and high bound estimate – duplicates the central estimate: [b] See Section 5.6 for bottom-up cost estimate: [d] not included in overall estimate.

11.7 Limitations

The costs due to premature mortality are reported in Chapter 3, but deaths resulting from childhood neglect or other adverse outcomes associated with parental drug use may not be detected using our search strategy in the NCIS. In Table 3.2 there were fewer than 5 deaths involving those aged 18 or younger, whereas we projected that they could be 14.5 deaths associated with cannabis use. We did not add these cases to the total number of deaths and here the cost reported is just that of conducting a child death review. Cases of childhood neglect or harm requiring hospital care represent a potential gap in the cost estimation as the analysis of hospital separation costs (Chapter 4) did not include separations for interpersonal violence, nor was accidental injury included as a possible form of hospital separation attributable to cannabis. While the data from child protection and child death reviews highlight these potential gaps, with the data that are publicly available we have not been able to the estimate the number of additional deaths or hospital episodes that should be added to those sections of the report.

The issue of poly-drug use in child maltreatment, as with other sections of this report, also complicated the allocation of cases to a specific drug. Indeed, there is the additional difficulty in that the drug use is likely to be by a parent or guardian rather that the person incurring the harm. It is also more difficult to assert that cannabis use by a parent or guardian caused the harm and not some other characteristic of the person. Given the multifactorial nature of child neglect and harm (Field, 2016) even when case file based studies identify substance use, it is not a definitive assertion of causality between substance use and the maltreatment.

In estimating the cost of school prevention programs and state-based prevention programs, we had to extrapolate from a single state (respectively Victoria and WA) to national costs: these states may not be representative of the spending across jurisdictions. Clearly this is not ideal. The report by the Auditor General Victoria (2003) is now dated and it did not include information on prevention programs delivered in non-Government schools. Thus, the estimate reported for school prevention should be regarded as preliminary. Furthermore, although prevention activities were included in our previous report on the costs of methamphetamine (Whetton et al., 2016) and extra-medical opioid use (Whetton et al., 2020), the expert advisory panel on tobacco recommended that, by convention, prevention activities are not included in assessing the social costs of tobacco in Australia (Whetton et al., 2019). Therefore, in this respect, the figure reported here is not directly comparable to the costs of tobacco use but does reflect the approach taken with both methamphetamine and opioid related costs.

It is unclear to what extent the DALY estimated in Section 10.2 for cannabis dependence incorporate ill-health due to schizophrenia and depression. The GBD provides an estimate of DALY separately for cannabis dependence and as a risk factor for schizophrenia (Degenhardt et al., 2013a) and reported DALY should include an adjustment for comorbidity (Murray et al., 2012). Thus, the DALY reported in this Chapter for cannabis-attributable depression and schizophrenia (Table 11.5) should be in addition to those from cannabis dependence (Table 10.2).

CHAPTER 12: CONCLUSIONS

Robert J. Tait, Steve Whetton, Aqif Mukhtar & Steve Allsop

12.1 Overall findings

This report assessed the social and economic costs of cannabis use in Australia for the financial year 2015/16 and is the fourth in a series assessing the societal costs of using specific substances (previously completed for methamphetamine, tobacco, and extra-medical opioids) to Australia. While each drug has unique costs and impacts, requiring different data to be sourced, the overarching approach remained the same. Overall, this report most closely replicated the methods of the analysis of extra-medical opioid-related costs, indeed much of the text describing the methods duplicates those in the earlier report (Whetton et al., 2020).

In Australia, about 10 percent of adults or, 2 million people, report that they have used cannabis in the last year and over 152,000 are thought to fulfil the criteria for dependence on cannabis (Australian Institute of Health and Welfare, 2017i; Global Burden of Disease Collaborative Network, 2018). We identified tangible costs of $4.4 billion arising from cannabis consumption. This represented about 98 percent of all costs, with intangibles contributing about $0.1 billion. We attributed 23 deaths to cannabis use, predominantly involving road traffic accidents. This finding was markedly different from the other drugs assessed in this series, with tobacco responsible for more than 20,000 deaths (Whetton et al., 2019), extra-medical opioids associated with 2,203 deaths (Whetton et al., 2020) and methamphetamine 170 deaths (Whetton et al., 2016). Table 12.1 summarises the difference in costs for extra-medical opioids and cannabis in each domain, with the overall cost of extra-medical opioid-related harms around three and half times that of cannabis.

Table 12.1: Comparison of extra-medical opioid- versus cannabis-related costs, 2015/16

Domain	Extra-medical opioid costs ($)	Cannabis costs [a] ($)	Difference in social costs (opioid – cannabis) $	Multiple (opioid v cannabis)
Tangible costs				
Premature mortality – tangible (gross)	2,623,976,267	29,548,645	2,594,427,622	88.8x higher
Avoided healthcare costs	-138,572,724	-627,598	-137,945,126	220.8x lower [b]
Hospital inpatient care	249,336,383	128,511,008	120,825,375	1.9x higher
Other health care	829,458,043	585,443,189	244,014,855	1.4x higher
Other workplace costs	458,666,743	560,208,687	-101,541,944	1.2x lower
Criminal justice	936,070,281	2,399,542,566	-1,463,472,285	2.6x lower
Traffic accidents	480,624,725	193,886,949	286,737,776	2.5x higher
Miscellaneous costs	193,964,241	469,979,798	-276,015,557	2.4x lower
Total tangible costs	**5,633,523,959**	**4,366,493,243**	**1,267,030,716**	1.3x higher
Intangible costs				
Premature mortality - intangible	10,127,150,276	106,199,655	10,020,950,621	95.4x higher
TOTAL COSTS	**15,760,674,235**	**4,472,692,898**	**11,287,981,337**	**3.5x higher**

[a] Source: Extra-medical opioid-related costs from Whetton et al (2020)

[b] The higher number for opioids translates to a lower cost for opioids as this category is 'savings' in health costs due to greater years of life lost.

The largest cost domain for cannabis was the criminal justice system, comprising police, courts, corrections and victims of crime, with a total impost of $2.4 billion. While the outlay on imprisonment accounted for nearly half of all the crime costs attributable to cannabis, there were estimated impacts on individuals (victims of personal crime) and on households (victims of property crime).

This report did not attempt to model the effect of changing the legal status of cannabis use (e.g. decriminalising or legalising) on the budgetary implications of cannabis-related crime. An early analysis from the USA suggested that there could be savings under a legalised approach, but that savings to the taxpayer could be minimal, with police likely to re-direct resources elsewhere (Caulkins, 2010). A more recent study compared outcomes in adjoining states (Washington and Oregon) with a two-year difference in enacting recreational cannabis legalisation (Dragone et al., 2019). From these quasi-experimental data, they reported a reduction in crime (e.g. rape down 15% to 30%: theft down 13% to 22%) (Dragone et al., 2019). While these findings provide interesting insights into the potential to reduce crimes associated with cannabis consumption, the impact across the whole economy needs to be assessed, to ensure that there are not countervailing impacts elsewhere. For example, some have noted that it is still unclear how changing the legal status of cannabis would impact on the consumption of other drugs (e.g. tobacco, alcohol, opioids) and whether this would result in increased or decreased public health costs overall (Hall and Lynskey, 2020).

Key to estimating the costs in the criminal justice system were the AF reported by detainees for their most serious offence. Overall, 8.0 percent attributed their offence to cannabis, in contrast to those who used heroin where only 3.4 percent attributed their offence to the use of heroin [37] (Whetton et al., 2020). Among those who used methamphetamine, the AF was 16.2 percent (Whetton et al., 2016). Finally, and in common with our previous reports on illicit drugs, there were cost areas where we were unable to allocate a figure to cannabis, in particular the portion of the Australian Federal Police budget that was relevant to cannabis and the costs involved in preventing the importation and distribution of cannabis.

Cannabis consumption impacts on workplace performance. Even though we only estimated costs for workplace injuries and absenteeism, the financial impost was $0.6 billion. However, it is also possible that employees affected by cannabis will have lower levels of productivity, for example due to intoxication or residual effects, than their co-workers, but we were unable to estimate a value for 'presenteeism'. There are also some effects of cannabis use that are likely to impact on the value of economic output more broadly, with daily use before the age of 17 associated with lower levels of educational attainment (Silins et al., 2015) and dependent use associated with lower levels of workforce participation (Fergusson and Boden, 2008) and hence have potentially life-long implications. We were unable to estimate the extent to which these factors would lower overall national productivity. Finally, there would also be costs for work-related road traffic accidents that we included with general road accidents ($194 million) elsewhere in the report.

There were relatively few deaths due to cannabis. However, there were 12,870 hospital inpatient events where cannabis was wholly or partially responsible for the event. The greatest outlay was for separations involving schizophrenia and other psychosis outcomes, although there were more separations involving mental health and behavioural disorders due to cannabis. An earlier study found that the treatment of

---

[37] The crime chapter of the extra-medical opioid report (Whetton et al., 2020), only considered heroin, not the broader category of extra-medical opioids.

psychosis accounted for 30 percent of the total health costs arising from cannabis (Ngui and Shanahan, 2010): in the case of hospital separations in the current report, the proportion was about 57 percent.

Unlike the report by Ngui and Shanahan (2010), we did not estimate the extent that cannabis-related schizophrenia impacted across all areas of health care. Nevertheless, we did estimate that medications used in the treatment of cannabis-attributable schizophrenia and other psychosis outcomes contributed a further $14 million to the total. These cannabis-related conditions would also have been likely to contribute to other areas in this domain, such as primary care attendance and community mental health treatment, again emphasising the importance of the relationship between cannabis use and development of psychotic disorders (Marconi et al., 2016).

Systematic reviews document the enormous social costs of schizophrenia including through reduced productivity, health care costs and burden on informal carers (Chong et al., 2016; Fasseeh et al., 2018; Jin and Mosweu, 2017). Given the evidence from some reports that the potency of cannabis has increased in recent decades, combined with declines in CBD (Chandra et al., 2019; ElSohly et al., 2016), which may potentially increase adverse effects (Di Forti et al., 2015; Large and Nielssen, 2017), there is the possibility of increasing health and economic implications in treating schizophrenia and other psychosis from cannabis. Therefore, it is important to monitor these trends and, depending on the emerging evidence, this may require that the AF for these conditions be updated before undertaking future analyses.

As was the case with respect to extra-medical use of opioids (Whetton et al., 2020), out-of-hospital care exceeded the cost of inpatient care, albeit that in-hospital care was the single largest component at 26.1 percent of the total cannabis-related health outlay. A major component of out-of-hospital care was treatment at specialist alcohol and other drug agencies, where cannabis was a drug of concern in 39 percent of episodes of care, and the primary drug in 23 percent of episodes (Australian Institute of Health and Welfare, 2017e).

The report also provided some preliminary estimates of other cost domains, but recognising the lack of rigorous methods or reliable data, we determined that these were not added to the cumulative total. By virtue of the prevalence of cannabis use, and in particular cannabis dependence, there is the potential for many other people to be affected. But of course, other factors, such as the nature and severity of adverse outcomes of use, can influence the extent of the effects on others. As noted in Chapter 10, we are unaware of any data on the household structure beyond marital status (Shanahan et al., 2016) of those with cannabis dependence and so the number of resident partners and children had to be estimated via the NDSHS, based on those reporting ‘daily’ cannabis use (Australian Institute of Health and Welfare, 2017i). Clearly this has limitations. Furthermore, we are unaware of any data reporting on the DALY from being co-resident with someone dependent on cannabis, so we drew on data from the alcohol field in deriving an approximation. From diagnostic criteria there are, by definition, impacts on others (e.g. continuing to use, even when it causes problems in relationships (American Psychiatric Association, 2013)) but the nature and magnitude of this needs to be quantified to allow the impact of cannabis and also dependence on other illicit drugs to be included in social cost studies.

We also estimated the effect of cannabis dependence both in terms of reduced quality of life and in relation to the purchase of cannabis. It is important to note that the latter element was just for those with ‘dependence’, where purchasing decisions may not fulfil the criteria for rational consumption (Becker and Murphy, 1988) and may be affected by factors such as withdrawal symptoms. We estimated that cannabis purchases amounted to $312 million, however, unlike the estimate of extra-medical opioid purchases, we were unable to 'triangulate' costs via data from wastewater analyses and had to rely solely on self-reports (Whetton et al., 2020). In estimating reduced quality of life, we did not offset this against any benefits, for example, if people were using (non-prescribed) cannabis to "self-medicate" for co-morbid health conditions, as we were unable to locate literature to support any such adjustment. Given the decision to allow the prescription of medical cannabis in Australia (Australian Government, 2016) and elsewhere, we anticipate that as evidence emerges on forms of "medical cannabis use" and specific impacts on health, this will have relevance for future cost calculations. However, care should be taken in extrapolating any findings of beneficial outcomes from medicinal use to the broader consumption of cannabis that may involve different and potentially more potent forms of cannabis, higher-risk modes of delivery and increased Δ^9-THC to CBD ratios, all of which can increase the risk of incurring harm (Fischer et al., 2017).

12.2 Limitations

As with our earlier reports on other drugs, there are a number of limitations that apply to social cost studies in general and some specific limitations that are likely to impact on evaluations of illicit drug use. The general limitations particularly focus on the availability of data, the frequency of use of more than one substance by consumers and of applying appropriate costs to the results of data typically collected for administrative purposes. In relation to consumption of illicit drugs there are fundamental questions about the accuracy of the data, especially when based on self-reports and with samples with high non-participation rates. With cannabis use, under-reporting might be less of a concern than for some other drugs, where use tends to be more stigmatised. Nevertheless, our key measure was 'dependence', based on data drawn from the GBD study (Global Burden of Disease Collaborative Network, 2018) that uses a variety of sources that need to include 'caseness' against standard clinical criteria in deriving its estimates (Vos et al., 2017).

The prevalence of dependence we used was far lower than if we had used the proxy measure of dependence based on self-reported 'daily' cannabis use (see Table 2.3 - 150,208 *versus* 292,906 people). The GBD data were for those aged 15 and older, while the NDSHS reported on those aged 14 and older (Australian Institute of Health and Welfare, 2017i; Global Burden of Disease Collaborative Network, 2018): this could have resulted in a more conservative estimate of the number of cases and hence the costs attributed. Alternatively, cannabis is ranked in the mid-range in terms of both causing dependence and in its social harms (Nutt et al., 2007), so there could be many people who are using cannabis frequently, but who either do not incur, or do not perceive that they are incurring, harms that would necessitate the use of treatment services.

The criminal justice system was the largest single cost domain. As with the earlier reports it is important to temper this finding with a consideration of the validity of generalising AF obtained from police detainees through other aspects of the system: police; courts; corrections; and, victims of crime. In each area the use of the AF in estimating costs can be questioned. Further, we did not include juveniles in our analysis as the equivalent AF for juvenile offenders is now dated (Prichard and Payne, 2005a, b). Given that the age of first use for cannabis is younger than that of methamphetamine or heroin use, the impact of this omission is likely to be greater than for those drugs. Conversely, offences that involve cannabis and young offenders are more likely to be dealt with via referral to social and health support services or specific cannabis initiatives, (Australian Institute of Health and Welfare, 2014) and may result in low social costs for young cannabis offenders compared with youth who have offences involving other illicit drugs (Shanahan et al., 2017).

Our estimate of the outlay on child protection cases ($386 million) needs to be considered in the light that it was based on two datasets: one drawn from a single state and the other a small sample from another state. Thus, there are implications in generalising the findings and in their potential accuracy. Given the potential lifetime detriments and costs that could arise in these cases, further research is recommended to establish the accuracy of our findings and, if confirmed, in developing interventions for families in this situation.

We intended to include low birthweight as a result of in utero exposure as an adverse outcome (Gunn et al., 2016) but were unable to identify information on the prevalence of cannabis use during pregnancy in Australia. We also note that there are some data suggesting the potential for birth abnormalities from early exposure (Reece, 2009). The difficulty of providing clear data from epidemiological studies where multiple confounding variables (e.g. alcohol use, tobacco smoking, social-economic factors) is acknowledged (National Academies of Sciences Engineering Medicine, 2017) but continued monitoring and research in this area is warranted.

12.3 Conclusions

Despite the greater prevalence of cannabis use, compared to other illicit drugs, the identified social and economic impacts of cannabis consumption, at $4.5 billion, are far lower than those of extra-medical opioids ($15.8 billion) and lower than for methamphetamine ($5.0 billion). Currently there is flux in cannabis policy and regulation in Australia and elsewhere. As such, this report provides an indication of current costs, in the context of some limited data and our discussion of limitations. It also provides baseline comparison findings. Increased access to medicinal cannabis may have relevance to trends in (non-medicinal) cannabis use across the community. Other policy changes, and any changes in the mode of use, intensity of use/dependence and potency will also have relevance. We have identified gaps in evidence and it is important that these are addressed to enable more accurate costs estimates but also to provide more accurate evidence to inform policy, prevention and treatment.

Early onset of cannabis use can have an impact on educational attainment: the subsequent downstream economic impacts for individuals and the community need to be identified. Changes to legislative controls may have a direct impact on costs to the criminal justice system. However, as we have noted, changes in the patterns, modes and prevalence of use, especially of more potent forms of cannabis, could also have impact on adverse outcomes of cannabis use, especially in relation to the workplace, road safety and mental health.

APPENDICES

Appendix 2.1 Attributable fractions

Table A2.1: Attributable fractions for cannabis-related conditions by age and sex

Condition	sex	age	Attributable fractions Central	Low	High
Cannabis mental and behavioural disorders	Male	All ages	1	1	1
Cannabis mental and behavioural disorders	Female	All ages	1	1	1
Cannabinoid Hyperemesis Syndrome	Male	All ages	1	1	1
Cannabinoid Hyperemesis Syndrome	Female	All ages	1	1	1
Chronic bronchitis	Male	15-49	0.02606	0.01059	0.043508
Chronic bronchitis	Female	15-49	0.013489	0.00544	0.022716
Chronic bronchitis	Male	50-69	0.013297	0.005362	0.022397
Chronic bronchitis	Female	50-69	0.005277	0.002117	0.008937
Chronic bronchitis	Male	70+	0.001451	0.000581	0.002465
Chronic bronchitis	Female	70+	0.000196	7.82E-05	0.000332
Schizophrenia and other psychosis outcomes	Male	15-49	0.072009	0.046923	0.104044
Schizophrenia and other psychosis outcomes	Female	15-49	0.03814	0.024541	0.056018
Schizophrenia and other psychosis outcomes	Male	50-69	0.037612	0.024197	0.055256
Schizophrenia and other psychosis outcomes	Female	50-69	0.01515	0.009666	0.022503
Schizophrenia and other psychosis outcomes	Male	70+	0.004198	0.002668	0.006269
Schizophrenia and other psychosis outcomes	Female	70+	0.000567	0.00036	0.000848
Depression	Male	15-49	0.016319	0.005588	0.030104
Depression	Female	15-49	0.008406	0.002863	0.015613
Depression	Male	50-69	0.008286	0.002822	0.015392
Depression	Female	50-69	0.003278	0.001113	0.006116
Depression	Male	70+	0.0009	0.000305	0.001683
Depression	Female	70+	0.000121	4.11E-05	0.000227
Road crash injuries	Male	Under 15	0.016716	0.006754	0.028088
Road crash injuries	Female	Under 15	0.004975	0.001996	0.008428
Road crash injuries	Male	15-49	0.016716	0.006754	0.028088
Road crash injuries	Female	15-49	0.004975	0.001996	0.008428
Road crash injuries	Male	50-69	0.016716	0.006754	0.028088
Road crash injuries	Female	50-69	0.004975	0.001996	0.008428
Road crash injuries	Male	70 and over	0.016716	0.006754	0.028088
Road crash injuries	Female	70 and over	0.004975	0.001996	0.008428

Note: We were unable to find the prevalence of cannabis use during pregnancy, so the AF could not be calculated

Appendix 5.1: Pharmaceutical benefit scheme codes

Table A5.1: PBS Items used for calculating pharmaceutical costs

Condition	PBS item codes
Psychosis and Schizophrenia 102 item(s)	10219W, 10224D, 10288L, 10289M, 10302F, 10341G, 10358E, 1037N, 1041T, 1042W, 10526B, 10529E, 1195X, 1196Y, 1197B, 1199D, 1201F, 1842Y, 1846E, 2255Q, 2257T, 2761H, 2763K, 2765M, 2766N, 2767P, 2768Q, 2770T, 3052P, 3053Q, 3169T, 3170W, 3171X, 3172Y, 3381Y, 3382B, 3384D, 3385E, 3455W, 3456X, 5100K, 5102M, 5103N, 5107T, 5109X, 5140M, 5141N, 5458G, 5626D, 5627E, 5628F, 5629G, 5630H, 6101D, 6102E, 6417R, 6418T, 8097E, 8100H, 8170B, 8185T, 8186W, 8187X, 8433W, 8434X, 8456C, 8457D, 8458E, 8580N, 8594H, 8595J, 8596K, 8717T, 8718W, 8719X, 8720Y, 8736T, 8780D, 8781E, 8782F, 8787L, 8789N, 8869T, 8952E, 8953F, 9070J, 9071K, 9072L, 9073M, 9079W, 9140C, 9141D, 9142E, 9202H, 9203J, 9204K, 9205L, 9293D, 9294E, 9295F, 9303P, 9632Y
Depression 56 item(s)	1011F, 1012G, 1013H, 10181W, 10231L, 10234P, 10241B, 10245F, 1357K, 1358L, 1434L, 1561E, 1627P, 1628Q, 1900B, 2236Q, 2237R, 2242B, 2417F, 2418G, 2420J, 2421K, 2429W, 2444P, 2522R, 2523T, 2856H, 3059B, 8003F, 8174F, 8220P, 8270G, 8290H, 8301X, 8302Y, 8512B, 8513C, 8583R, 8700X, 8701Y, 8702B, 8703C, 8836C, 8837D, 8855C, 8856D, 8857E, 8868R, 8883M, 9155W, 9156X, 9365X, 9366Y, 9367B, 9432K, 9433L
Chronic Bronchitis 70 item(s)	10059K, 10124W, 10156M, 10187E, 10188F, 10509D, 5134F, 5137J, 8626B, 10007Q, 10008R, 10015D, 10018G, 10024N, 10034D, 10143W, 1034K, 1103C, 1542E, 1934T, 1935W, 1936X, 2000G, 2001H, 2065Q, 2066R, 2070Y, 2071B, 2072C, 2614N, 2634P, 2817G, 2827T, 3495Y, 3496B, 3497C, 4089F, 4090G, 4092J, 8136F, 8141L, 8147T, 8148W, 8149X, 8230E, 8231F, 8238N, 8239P, 8240Q, 8288F, 8345F, 8346G, 8354Q, 8406K, 8407L, 8408M, 8409N, 8430Q, 8431R, 8432T, 8516F, 8517G, 8518H, 8519J, 8625Y, 8671J, 8750M, 8796Y, 8853Y, 8854B

PBS = Pharmaceutical Benefits Scheme.

Appendix 6.1: Safe Work Australia's incident approach methodology

Safe Work Australia's incidence approach assessed the number of people entering the compensation system during 2012/13 as a result of a work-related incident and the costs (both current and expected future costs) associated with those cases. In order to estimate total costs, the expected future lifetime cost of each new cases was used to represent the cost of cases in the reference year that were already in the compensation system (Safe Work Australia, 2015).

Appendix 6.2: Safe Work Australia's cost estimation methodology

The cost estimation methodology utilised by Safe Work Australia (2015) was based on the concept of the 'human cost' of occupational injury with only costs associated with actual injuries including:

- Production costs - costs incurred in the short term until production is returned to pre-incident levels;
- Human capital costs - long run costs, such as loss of potential output, occurring after a restoration of pre-incident production levels;
- Medical costs - costs incurred by workers and the community though medical treatment of workers injured in work-related incidents;
- Administrative costs - costs incurred in administering compensation schemes, investigating incidents and legal costs;
- Transfer costs - deadweight losses associated with the administration of taxation and welfare payments; and,
- Other costs - costs not classified in other areas, such as the cost of carers and aids and modifications (Safe Work Australia, 2015).

Appendix 6.3: Recalculated workplace absenteeism costs with different daily wage estimate

The Social Costs of Methamphetamine in Australia (Whetton et al., 2016) used a similar methodology to that reported here (see Section 6.2.2). The main difference between the two costing projects was the year (2013 vs 2015) and type of daily wage value used (trend estimates vs seasonally adjusted estimates) from the ABS average weekly earnings report. The ABS provides average weekly earnings that are seasonally adjusted and trend estimates (see explanatory notes in https://www.abs.gov.au/ausstats/abs@.nsf/mf/6302.0 for more information). The methamphetamine costing project used November 2013 weekly wage trend data for person's total earnings (Australian Bureau of Statistics, 2014b). The daily wage calculated was $267.70 (including 20% employer on-costs). Workplace absenteeism costs attributed to the use of cannabis was determined using seasonally adjusted full-time adult total weekly earnings for November 2015 (Australian Bureau of Statistics, 2016a). The daily wage calculated was $373.66 (including 20% employer on-costs). The following three tables recalculate the cost of cannabis use using the daily wage of $274.94. This daily wage was calculated from person's total weekly earnings for November 2015 (trend data) with 20% employer on-costs added (Australian Bureau of Statistics, 2016a). It is also important to note that the NDSHS collection years were different with the present report using 2016 data whilst the methamphetamine report used 2013 data.

Recalculated Table 6.5: Compares the adjusted excess workplace absenteeism due to illness/injury for those who use cannabis, and those who do not use drugs (2016 NDSHS data [a]) and associated costs (2015 ABS data [b]) [c d]

Drug use status	Estimated Population	Annual Illness or Injury Absence			
		Mean Days Absent (95% CI)	Difference [e] (95% CI)	Excess Days Absent (95% CI) [f]	Cost $ (95% CI) [g]
No drugs	8,536,278	7.556 (6.908 – 8.203)			
Cannabis	1,275,639	11.077 (9.443 – 12.710)	3.521 (2.535 – 4.507)	4,491,577 (3,234,312 – 5,748,843)	1,234,914,241 (889,241,847 – 1,580,586,947)
Cannabis (excluding tobacco [h])	419,303	12.468 (10.596 – 14.338)	4.912 (3.688 – 6.135)	2,059,795 (1,546,294 – 2,572,596)	566,319,989 (425,138,011 – 707,309,584)

[a] Australian Institute of Health and Welfare, 2017. National Drug Strategy Household Survey (NDSHS) 2016, Drug Statistics Series. Canberra, Government of Australia.
[b] Australian Bureau of Statistics (ABS), 2016. Average Weekly Earnings, Australia, Nov 2015. Cat. no. 6302.0. Canberra, ABS.
[c] Calculations based on estimated absenteeism means adjusted for age, gender, marital status, socio-economic status, and occupation.
[d] ANCOVA results related to other drugs are not reported.
[e] Mean days absent due to illness/injury for cannabis use minus mean days absent for no drug use.
[f] Difference in mean absence multiplied by estimated population.
[g] Excess absence multiplied by $274.94 (2015 average daily wage for person total earnings (trend data) plus 20% employer on-costs).
[h] Excludes those who are daily, occasional, and ex-smokers as the costs associated with tobacco use (including concurrent use of cannabis) are accounted for in Whetton et al. (2019).

Recalculated Table 6.6: Adjusted excess workplace absenteeism due to drug use by drug use type (2016 NDSHS data [a]) and associated costs (2015 ABS data [b]) [c d]

Drug use status	Estimated Population	Annual Absence due to drug use		
		Mean Days Absent (95% CI)	Excess Days Absent (95% CI) [e]	Cost $ (95% CI) [f]
Cannabis	1,275,639	0.268 (0.029 – 0.506)	341,282 (37,577 – 644,987)	93,832,047 (10,331,481 – 177,332,656)

[a] Australian Institute of Health and Welfare, 2017. National Drug Strategy Household Survey (NDSHS) 2016, Drug Statistics Series. Canberra, Government of Australia.
[b] Australian Bureau of Statistics (ABS), 2016. Average Weekly Earnings, Australia, Nov 2015. Cat. no. 6302.0. Canberra, ABS.
[c] Calculations based on estimated absenteeism means adjusted for age, gender, marital status, socio-economic status, and occupation.
[d] ANCOVA results related to other drugs are not reported.
[e] Days in excess of those who do not use drugs. Mean days absent multiplied by estimated population.
[f] Excess absence multiplied by $274.94 (2015 average daily wage for person total earnings (trend data) plus 20% employer on-costs).

Recalculated Table 6.8a: Summary: Workplace costs due to cannabis use

Cost area	Central estimate $	Low bound $	High bound $
Occupational injury [a]	297,720,000	297,720,000 [b]	297,720,000 [b]
Absenteeism	193,139,858[c]	54,904,650	331,375,067
Total	**490,859,858**	**372,624,650**	**629,095,067**

[a] Cost to employer ($57,620,000) plus cost to community ($240,100,000). Employee costs are an internal cost and thus not included in the total cost estimate for occupation injury (see Table 6.3).
[b] The low/high bound estimate duplicates the central estimate.
[c] The mid-point of the low and high bound estimates.
Note: the figures in Recalculated Table 6.8 account for poly-substance use. That is, illness/injury-related absenteeism (Recalculated Table 6.5) and drug-related absenteeism (Recalculated Table 6.6) costs attributed to cannabis use were divided by 1.709 (see Section 6.3.2 and Table 6.7 for more information about this procedure).

In Appendix 6.4 we report the results for the total costs attributed to cannabis use unadjusted for tobacco use.

Appendix 6.4: Recalculated workplace absenteeism costs when unadjusted for tobacco

The unadjusted costs attributed to injury/illness and drug-related absenteeism are detailed in Appendix Table 6.4.

Appendix Table 6.4: Adjusted workplace absenteeism costs due to cannabis use (2016 NDSHS data [a] and 2015 ABS data [b]) [c]

Cost area	Central estimate $	Low bound $	High bound $
Injury/illness absence	1,678,322,744	1,208,533,166	2,148,112,748
Drug-related absence	127,523,397	14,041,104	241,005,747
Total	**1,805,846,141**	**1,222,574,270**	**2,389,118,495**
Injury/illness absence adjusted for polydrug use	982,049,587	707,158,084	1,256,941,339
Drug-related absence adjusted for polydrug use	74,618,723	8,215,977	141,021,502
Total	**1,056,668,310**	**715,374,061**	**1,397,962,841**

[a] Australian Institute of Health and Welfare, 2017. National Drug Strategy Household Survey (NDSHS) 2016, Drug Statistics Series. Canberra, Government of Australia.
[b] Australian Bureau of Statistics (ABS), 2016. Average Weekly Earnings, Australia, Nov 2015. Cat. no. 6302.0. Canberra, ABS.
[c] Cost data extracted from Table 6.5 and Table 6.6. Refer to these tables for additional information regarding cost calculations.

In order to account for drug-related absenteeism (Table 6.5 and Table 6.6) due to poly-substance use (Table 6.7) the total cost for cannabis use was divided by 1.709 (i.e. the summed proportion of those who used cannabis who also used other drugs). This resulted in an annual cost of cannabis-attributable absenteeism due to drug use and illness/injury of **$74.6 million** [38] and **$982.0 million** [39], respectively (Appendix Table 6.4). The cost attributable to *drug use* related absenteeism (**$74.6 million)** is likely to be a conservative estimate as it was obtained from a self-report measure of absenteeism that respondents attributed to drug use and was used as our low bound estimate for absenteeism (recalculated Table 6.8b). The cost attributed to *injury and illness* absenteeism (**$982.0 million)** however is likely to be an overestimate as higher proportions of those who use cannabis also smoke tobacco (see Table 6.5) and/or drink alcohol at risky levels, compared to the general working population (National Centre for Education and Training on Addiction, 2019a). Both of these licit drugs have substantial

[38] The cost of cannabis use attributed to drug-related absenteeism ($127,523,397) divided by 1.709.
[39] The cost of cannabis use attributed to illness/injury absenteeism ($1,678,322,744) divided by 1.709.

negative impacts on physical health and are unaccounted for in the estimates presented here (see Table 6.5 for adjusted costs that exclude tobacco). The cost attributed to injury and illness absenteeism was used as the high bound estimate, with the mid-point (**$528.3 million**) used as the central estimate (Recalculated Table 6.8b).

Recalculated Table 6.8b: Summary: Workplace costs due to cannabis use

Cost area	Central estimate $	Low bound $	High bound $
Occupational injury [a]	297,720,000	297,720,000 [b]	297,720,000 [b]
Absenteeism	528,334,155 [c]	74,618,723	982,049,587
Total	**826,054,155**	**372,338,723**	**1,279,769,587**

[a] Cost to employer ($57,620,000) plus cost to community ($240,100,000). Employee costs are an internal cost and thus not included in the total cost estimate for occupation injury (see Table 6.3).
[b] The low/high bound estimate duplicates the central estimate.
[c] The mid-point of the low and high bound estimates.

The total cost of cannabis (unadjusted for tobacco) to Australian workplaces is estimated to be **$826.1 million** (Recalculated Table 6.8b).

REFERENCES

Abelson, P., 2008. Establishing a monetary value for lives saved: Issues and controversies, Working Papers in Cost-Benefit Analysis. WP 2008-02, Office of Best Practice Regulation, Department of Finance and Deregulation.

Akerlof, G., 1991. Procrastination and obedience. *American Economic Review* 81, 1-19.

Aldington, S., Williams, M., Nowitz, M., Weatherall, M., Pritchard, A., McNaughton, A., Robinson, G., Beasley, R., 2007. Effects of cannabis on pulmonary structure, function and symptoms. *Thorax* 62, 1058-1063.

American Psychiatric Association, 2013. Diagnostic and Statistical Manual of Mental Disorders 5th Edition. APA, Washington DC.

Angeletos, G.-M., Laibson, D., Repetto, A., Tobacman, J., Weinberg, S., 2001. The hyperbolic consumption model: Calibration, simulation, and empirical evaluation. *Journal of Economic Perspectives* 15, 47-68.

Arendt, M., Munk-Jørgensen, P., Sher, L., Jensen, S.O.W., 2013. Mortality following treatment for cannabis use disorders: Predictors and causes. *Journal of Substance Abuse Treatment* 44, 400-406.

Arria, A.M., Mericle, A.A., Meyers, K., Winters, K.C., 2012. Parental substance use impairment, parenting and substance use disorder risk. *Journal of Substance Abuse Treatment* 43, 114-122.

Auditor General Victoria, 2003. Drug Education in Government Schools. Melbourne, Government of Victoria.

Australian Bureau of Statistics, 1997. Unpaid Work and the Australian Economy, Cat. no.5240. Canberra, ABS.

Australian Bureau of Statistics, 2011. Australian and New Zealand Standard Offence Classification, Cat. no. 1234.0. ABS, Canberra.

Australian Bureau of Statistics, 2014a. Criminal Courts 2013-14, Cat. no. 4513.0. Canberra, ABS.

Australian Bureau of Statistics, 2014b. Average Weekly Earnings, Australia, Nov 2013, Cat. no. 6302.0. Canberra, ABS.

Australian Bureau of Statistics, 2016a. Average Weekly Earnings, Australia, Nov 2015. Cat. no. 6302.0. Canberra, ABS.

Australian Bureau of Statistics, 2016b. Disability, Ageing and Carers, Australia, Cat. no. 4430.0. Canberra, ABS.

Australian Bureau of Statistics, 2016c. Consumer Price Index, Australia, December 2015, Table 1, Cat. no. 6401.0. Canberra, ABS.

Australian Bureau of Statistics, 2016d. Prisoners in Australia, Cat. no. 4517.0. Canberra, ABS.

Australian Bureau of Statistics, 2017a. Criminal Courts, Australia, 2015-16, Cat. no. 4513.0. Canberra, ABS.

Australian Bureau of Statistics, 2017b. Confidentialised Unit Record File, Disability, Ageing and Carers, Australia, 2015, Cat. no.4430.0.30.002. Canberra, ABS.

Australian Bureau of Statistics, 2017c. 2016 Census of Population and Housing, Tablebuilder Pro database. Canberra, ABS.

Australian Bureau of Statistics, 2017d. Schools, Australia, Cat. no. 4221.0 Canberra, ABS.

Australian Bureau of Statistics, 2017e. Recorded Crime - Offenders, 2015-16. Canberra, ABS.

Australian Bureau of Statistics, 2017f. Crime Victimisation, Australia 2015-16, Cat. no. 4530.0. Canberra, ABS.

Australian Bureau of Statistics, 2017g. Prisoners in Australia, Cat. no. 4517.0. Canberra, ABS.

Australian Bureau of Statistics, 2018a. Life Tables, States, Territories and Australia, 2015-2017, Cat. no. 3302.055.001. Canberra, ABS.

Australian Bureau of Statistics, 2018b. Australian Demographic Statistics, Cat. no. 3101.0. Canberra, ABS.
Australian Bureau of Statistics, 2018c. Australian National Accounts: National Income, Expenditure and Product, Dec 2017, Table 34, Cat. no. 5206.0. Canberra, ABS.
Australian Bureau of Statistics, 2019a. Labour Force Australia. Cat no. 6202.0, Canberra, ABS.
Australian Bureau of Statistics, 2019b. Causes of Death, Australia, 2018, Cat. no. 3303.0. Canberra, ABS.
Australian Bureau of Statistics, 2019c. Consumer Price Index Inflation Calculator. Canberra, ABS. http://www.abs.gov.au/websitedbs/d3310114.nsf/home/Consumer+Price+Index+Inflation+Calculator
Australian Bureau of Statistics, 2019d. Australian National Accounts: National Income, Expenditure and Product. Cat no. 5206.0, Canberra, Commonwealth of Australia.
Australian Consortium for Classification Development, 2014. The International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification (ICD-10-AM): Nineth edition. Darlinghurst, NSW, Independent Hospital Pricing Authority.
Australian Criminal Intelligence Commission, 2018. National Wastewater Drug Monitoring Program—Report 4. Canberra, ACIC.
Australian Government, 2016. Narcotic Drugs Amendment Act 2016, No. 12. Federal Register of Legislation, Canberra.
Australian Institute of Criminology, 2019. Drug use monitoring in Australia, data extraction: AIC DUMA collection 2015-16 [computer file], AIC, Canberra.
Australian Institute of Health and Welfare, 2012. Dementia in Australia Cat. no. AGE 70. Canberra, AIHW.
Australian Institute of Health and Welfare, 2014. Alcohol and other drug treatment and diversion from the Australian criminal justice system 2012/13, Bulletin 125. Canbaerra, AIHW.
Australian Institute of Health and Welfare, 2016a. Child protection Australia 2014-15, Child Welfare Series no. 63. Canberra, AIHW.
Australian Institute of Health and Welfare, 2016b. Emergency department care 2015–16: Australian hospital statistics, Health Services Series no. 72. Cat. no. HSE 182. Canberra, AIHW.
Australian Institute of Health and Welfare, 2017a. Non-admitted patient care 2015–16: Australian hospital statistics, Health Services Series No. 76. Canberra, Government of Australia.
Australian Institute of Health and Welfare, 2017b. Admitted patient care 2015-16. Australian hospital statistics, Health Services Series No. 75. Canberra, Government of Australia.
Australian Institute of Health and Welfare, 2017c. National drug strategy household survey 2016 questionnaire. Canberra, AIHW.
Australian Institute of Health and Welfare, 2017d. Alcohol and other drug treatment services in Australia 2015-16, Drug Treatment Series No. 29. Canberra, AIHW.
Australian Institute of Health and Welfare, 2017e. 2016 National drug strategy household survey: Online data tables, AIHW, Canberra.
Australian Institute of Health and Welfare, 2017f. Health expenditure Australia 2015–16, Health and Welfare Expenditure series no. 58. Canberra, AIHW.
Australian Institute of Health and Welfare, 2017g. Alcohol and other drug treatment services in Australia 2015–16: Supplementary tables, Drug Treatment Series no. 29. Cat. no. HSE 187, Canberra, AIHW.
Australian Institute of Health and Welfare, 2017h. National drug strategy household survey 2016, Drug Statistics Series. Canberra, Government of Australia.
Australian Institute of Health and Welfare, 2017i. National drug strategy household survey 2016: Confidentialised unit record file. Available from the Australian Data Archive, Canberra, AIHW.
Australian Institute of Health and Welfare, 2018. Impact of alcohol and illicit drug use on the burden of disease and injury in Australia: Australian Burden of Disease Study 2011, Australian Burden of Disease Study Series no. 17. Cat. no. BOD 19. Canberra, AIHW.

Australian Institute of Health and Welfare, 2019a. State and territory community mental health care services 2015-16, Mental Health Services in Australia. 16 July 2019, Canberra, AIHW.
Australian Institute of Health and Welfare, 2019b. Australian Burden of Disease Study: Impact and causes of illness and death in Australia 2015, Australian Burden of Disease series no. 19. Cat. no. BOD 22. Canberra, AIHW.
Australian Safety and Compensation Council, 2007. Work-related alcohol and drug use - A fit for work issue. Canberra, Government of Australia.
Baker, R., Bateman, I., Donaldson, C., Jones-Lee, M., Lancsar, E., Loomes, G., Mason, H., Odejar, M., Pinto Prades, J.L., Robinson, A., Ryan, M., Shackley, P., Smith, R., Sugden, R., Wildman, J., 2010. Weighting and Valuing Quality-Adjusted Life-Years Using Stated Preference Methods: Preliminary Results from the Social Value of a QALY Project. *Health Technology Assessment* 14, 1-161.
Barrio, G., Jiménez-Mejías, E., Pulido, J., Lardelli-Claret, P., Bravo, M.J., de la Fuente, L., 2012. Association between cannabis use and non-traffic injuries. *Accident Analysis and Prevention* 47, 172-176.
Becker, G.S., Murphy, K.M., 1988. A theory of rational addiction. *Journal of Political Economy* 96, 675-700.
Bennett, T., Holloway, K., Farrington, D., 2008. The statistical association between drug misuse and crime: A meta-analysis. *Aggression and Violent Behavior* 13, 107-118.
Bergamaschi, M.M., Karschner, E.L., Goodwin, R.S., Scheidweiler, K.B., Hirvonen, J., Queiroz, R.H., Huestis, M.A., 2013. Impact of prolonged cannabinoid excretion in chronic daily cannabis smokers' blood on per se drugged driving laws. *Clinical Chemistry* 59, 519-526.
Bhatt, S., Queen, J., 2019. Cannabinoid hyperemesis syndrome. *Current Emergency and Hospital Medicine Reports* 7, 14-18.
Birkeland, B., Foster, K., Selbekk, A.S., Høie, M.M., Ruud, T., Weimand, B., 2018. The quality of life when a partner has substance use problems: A scoping review. *Health and quality of life outcomes* 16, 219.
Borges, G., Bagge, C.L., Orozco, R., 2016. A literature review and meta-analyses of cannabis use and suicidality. *Journal of Affective Disorders* 195, 63-74.
Bradford, A.C., Bradford, W.D., 2017. Medical marijuana laws may be associated with a decline in the number of prescriptions for Medicaid enrollees. *Health Affairs* 36, 945-951.
Britt, H., Miller, G., Henderson, J., Bayram, C., Harrison, C., Valenti, L., Pan, Y., Charles, J., Pollack, A., Wong, C., Gordon, J., 2016. General practice activity in Australia 2015–16, General Practice Series no. 40. Sydney, Sydney University Press.
Bromfield, L., Higgins, D., 2005. National comparison of child protection systems, Child Abuse Prevention Issues. Canberra, Australian Institute of Family Studies.
Bugeja, L., Ibrahim, J.E., Ferrah, N., Murphy, B., Willoughby, M., Ranson, D., 2016. The utility of medico-legal databases for public health research: a systematic review of peer-reviewed publications using the National Coronial Information System. *Health Research Policy and Systems* 14, 28.
Bureau of Infrastructure Transport and Regional Economics, 2009. Road Crash Costs in Australia 2006, Report 118. Canberra, BITRE.
Bureau of Infrastructure Transport and Regional Economics, 2017. Road Trauma Australia 2016, Statistical Summary. Canberra, BITRE.
Bureau of Infrastructure Transport and Regional Economics, 2019. 2019 Australian Road Deaths Database: Fatalities. Australian Government, Australia. 26 Aug 2019. https://www.bitre.gov.au/statistics/safety/fatal_road_crash_database.aspx
Bush, R., Wooden, M., 1995. Smoking and absence from work: Australian evidence. *Social Science and Medicine* 41, 437-446.
Callinan, S., Laslett, A.-M., Rekve, D., Room, R., Waleewong, O., Benegal, V., Casswell, S., Florenzano, R., Hanh, H.T.M., Hanh, V.T.M., 2016. Alcohol's harm to others: An international collaborative project. *International Journal of Alcohol and Drug Research* 5, 25-32.

Canadian Substance Use Costs and Harms Scientific Working Group, 2018. Canadian substance use costs and harms (2007–2014). Ottawa, Ont., Prepared by the Canadian Institute for Substance Use Research and the Canadian Centre on Substance Use and Addiction.

Caulkins, J.P., 2010. Cost of marijuana prohibition on the California criminal justice system, Drug Policy Research Center Working Paper. WR-763-RC, Santa Monica, CA, RAND.

Cawley, J., Ruhm, C.J., 2011. The economics of risky health behaviors. In: Pauly, M.V., McGuire, T.G., Barros, P.P. (Eds.), The Handbook of Health Economics, volume 1. North-Holland, Oxford.

Centrelink, 2015. A Guide to Australian Government Payments, 1 July to 19 September 2015. Canberra, Australian Government Department of Human Services.

Cerdá, M., Wall, M., Feng, T., Keyes, K.M., Sarvet, A., Schulenberg, J., O'Malley, P.M., Pacula, R.L., Galea, S., Hasin, D.S., 2017. Association of state recreational marijuana laws with adolescent marijuana use. *Journal of the American Medical Association Pediatrics* 171, 142-149.

Ch'ng, C.W., Fitzgerald, M., Gerostamoulos, J., Cameron, P., Bui, D., Drummer, O.H., Potter, J., Odell, M., 2007. Drug use in motor vehicle drivers presenting to an Australian, adult major trauma centre. *Emergency Medicine Australasia* 19, 359-365.

Chaffin, M., Kelleher, K., Hollenberg, J., 1996. Onset of physical abuse and neglect: Psychiatric, substance abuse, and social risk factors from prospective community data. *Child Abuse and Neglect* 20, 191-203.

Chalmers, J., Lancaster, K., Hughes, C., 2016. The stigmatisation of 'ice' and under-reporting of meth/amphetamine use in general population surveys: A case study from Australia. *International Journal of Drug Policy*, dx.doi.org/doi:10.1016/j.drugpo.2016.1006.1001.

Chandra, S., Radwan, M.M., Majumdar, C.G., Church, J.C., Freeman, T.P., ElSohly, M.A., 2019. New trends in cannabis potency in USA and Europe during the last decade (2008–2017). *European Archives of Psychiatry and Clinical Neuroscience* 269, 5-15.

Chihuri, S., Li, G., 2019. Use of prescription opioids and initiation of fatal 2-vehicle crashes. *JAMA Network Open* 2, e188081-e188081.

Chocron, Y., Zuber, J.-P., Vaucher, J., 2019. Cannabinoid hyperemesis syndrome. *British Medical Journal* 366, l4336.

Chong, H.Y., Teoh, S.L., Wu, D.B.-C., Kotirum, S., Chiou, C.-F., Chaiyakunapruk, N., 2016. Global economic burden of schizophrenia: A systematic review. *Neuropsychiatric Disease and Treatment* 12, 357-373.

Chrzanowska, A., Man, N., Degenhardt, L., Dobbins, T., Peacock, A., 2019. Trends in drug related hospital separations in Australia, 1999-2018, Drug Trends Bulletin Series Sydney, National Drug and Alcohol Research Centre, UNSW.

Chu, M., Gerostamoulos, D., Beyer, J., Rodda, L., Boorman, M., Drummer, O.H., 2012. The incidence of drugs of impairment in oral fluid from random roadside testing. *Forensic Science International* 215, 28-31.

Collins, D.J., Lapsley, H.M., 1996. The social costs of drug abuse in Australia in 1988 and 1992, National Drug Strategy Monograph Series No. 30. Canberra, Commonwealth Department of Health & Human Services.

Collins, D.J., Lapsley, H.M., 2002. Counting the cost: Estimates of the social costs of drug abuse in Australia in 1998-9, National Drug Strategy Monograph Series No. 49. Canberra, Commonwealth Deapartment of Health & Ageing.

Collins, D.J., Lapsley, H.M., 2008. The costs of tobacco, alcohol and illicit drug abuse to Australian society in 2004/05, National Drug Strategy Monograph Series No. 64. Canberra, Commonwealth of Australia.

Commonwealth Director of Public Prosecutions, 2016. Annual Report, 2015-16. Canberra, CDPP.

Community Affairs References Committee, 2015. Availability of new, innovative and specialist cancer drugs in Australia. Canberra, The Senate, Commonwealth of Australia.

Conner, S.N., Bedell, V., Lipsey, K., Macones, G.A., Cahill, A.G., Tuuli, M.G., 2016. Maternal marijuana use and adverse neonatal outcomes: A systematic review and meta-analysis. *Obstetrics and Gynecology* 128, 713-723.
Copeland, J., Swifta, W., Reesb, V., 2001. Clinical profile of participants in a brief intervention program for cannabis use disorder. *Journal of Substance Abuse Treatment* 20, 52.
Copeland, J., 2016. Cannabis use and its associated disorders: Clinical care. *Australian Family Physician* 45, 874.
Cornfield, J., 1951. A method of estimating comparative rates from clinical data. Applications to cancer of the lung, breast, and cervix. *Journal of the National Cancer Institute* 11, 1269-1275.
Costa, D.L., Kahn, M.E., 2004. Changes in the Value of Life, 1940–1980. *Journal of Risk and Uncertainty* 29, 159-180.
Council of Obstetric and Paediatric Mortality and Morbidity, 2017. Annual Report 2015. Hobart, Department of Health and Human Services, Tasmania.
Council of Obstetric and Paediatric Mortality and Morbidity, 2018. Annual Report 2016. Hobart, Department of Health and Human Services, Tasmania.
Darke, S., Duflou, J., Farrell, M., Peacock, A., Lappin, J., 2019. Characteristics and circumstances of synthetic cannabinoid-related death. *Clinical Toxicology*, 1-7.
Davey, J., Freeman, J., 2009. Screening for drugs in oral fluid: Drug driving and illicit drug use in a sample of Queensland motorists. *Traffic Injury Prevention* 10, 231-236.
Degenhardt, L., Ferrari, A.J., Calabria, B., Hall, W.D., Norman, R.E., McGrath, J., Flaxman, A.D., Engell, R.E., Freedman, G.D., Whiteford, H.A., Vos, T., 2013a. The global epidemiology and contribution of cannabis use and dependence to the global burden of disease: Results from the GBD 2010 study. *PloS One* 8, e76635-e76635.
Degenhardt, L., Whiteford, H.A., Ferrari, A.J., Baxter, A.J., Charlson, F.J., Hall, W.D., Freedman, G., Burstein, R., Johns, N., Engell, R.E., 2013b. Supplement to: Global burden of disease attributable to illicit drug use and dependence: findings from the Global Burden of Disease Study 2010. *The Lancet* 382.
Degenhardt, L., Whiteford, H.A., Ferrari, A.J., Baxter, A.J., Charlson, F.J., Hall, W.D., Freedman, G., Burstein, R., Johns, N., Engell, R.E., Flaxman, A., Murray, C.J.L., Vos, T., 2013c. Global burden of disease attributable to illicit drug use and dependence: Findings from the Global Burden of Disease Study 2010. *The Lancet* 382, 1564-1574.
Degenhardt, L., Charlson, F., Ferrari, A.J., Santomauro, D., Erskine, H., Mantilla-Herrara, A., Whiteford, H.A., Leung, J., Naghavi, M., Griswold, M., 2018. The global burden of disease attributable to alcohol and drug use in 195 countries and territories, 1990–2016: A systematic analysis for the Global Burden of Disease Study 2016. *The Lancet Psychiatry* 5, 987-1012.
Deloitte Access Economics, 2015. The Economic Value of Informal Care in Australia in 2015. Canberra, Carers Australia.
Department of Finance and Administration, 2006. Handbook of cost–benefit analysis, Financial Management Reference Material No. 6. Canberra, Commonwealth of Australia.
Department of the Prime Minister and Cabinet, 2016. Cost-Benefit Analysis: Guidance Note. Canberra, Office of Best Practice Regulation, Australian Government.
Department of Veterans' Affairs, 2018. Factsheet HSV92 - Repatriation Pharmaceutical Benefits Scheme. DVA Australian Government, Canberra. 3 Sept 2018. https://www.dva.gov.au/factsheet-hsv92-repatriation-pharmaceutical-benefits-scheme
Di Forti, M., Sallis, H., Allegri, F., Trotta, A., Ferraro, L., Stilo, S.A., Marconi, A., La Cascia, C., Reis Marques, T., Pariante, C., Dazzan, P., Mondelli, V., Paparelli, A., Kolliakou, A., Prata, D., Gaughran, F., David, A.S., Morgan, C., Stahl, D., Khondoker, M., MacCabe, J.H., Murray, R.M., 2014. Daily use, especially of high-potency cannabis, drives the earlier onset of psychosis in cannabis users. *Schizophrenia Bulletin* 40, 1509-1517.

Di Forti, M., Marconi, A., Carra, E., Fraietta, S., Trotta, A., Bonomo, M., Bianconi, F., Gardner-Sood, P., O'Connor, J., Russo, M., 2015. Proportion of patients in south London with first-episode psychosis attributable to use of high potency cannabis: A case-control study. *The Lancet Psychiatry* 2, 233-238.

Director of Public Prosecutions, 2016. Annual Report, 2015-16. Melbourne, ODPP.

Director of Public Prosecutions Northern Territory, 2016. 26th Annual Report 2015-2016. Darwin, DPP.

Doktorchik, C., Patten, S., Eastwood, C., Peng, M., Chen, G., Beck, C.A., Jetté, N., Williamson, T., Quan, H., 2019. Validation of a case definition for depression in administrative data against primary chart data as a reference standard. *BMC Psychiatry* 19, 9.

Dolan, P., Loomes, G., Peasgood, T., Tsuchiya, A., 2005. Estimating the intangible victim costs of violent crime. *British Journal of Criminology* 45, 958-976.

Dolan, P., 2010. Thinking about it: Thoughts about health and valuing QALYs. *Health Economics* 20, 1407–1416.

Donaldson, C., Baker, R., Mason, H., Jones-Lee, M., Lancsar, E., Wildman, J., Bateman, I., Loomes, G., Robinson, A., Sugden, R., Pinto Prades, J.L., Ryan, M., Shackley, P., Smith, R., 2011. The social value of a QALY: Raising the bar or barring the raise? *BMC Health Services Research* 11.

Dragone, D., Prarolo, G., Vanin, P., Zanella, G., 2019. Crime and the legalization of recreational marijuana. *Journal of Economic Behavior and Organization* 159, 488-501.

Dresen, S., Ferreirós, N., Pütz, M., Westphal, F., Zimmermann, R., Auwärter, V., 2010. Monitoring of herbal mixtures potentially containing synthetic cannabinoids as psychoactive compounds. *Journal of Mass Spectrometry* 45, 1186-1194.

Drummer, O.H., Gerostamoulos, J., Batziris, H., Chu, M., Caplehorn, J.R., Robertson, M.D., Swann, P., 2003. The incidence of drugs in drivers killed in Australian road traffic crashes. *Forensic Science International* 134, 154-162.

Ekpu, V.U., Brown, A.K., 2015. The economic impact of smoking and of reducing smoking prevalence: Review of evidence. *Tobacco Use Insights* 8, 1-35.

Els, C., Jackson, T., Tsuyuki, R., Aidoo, H., Wyatt, G., Sowah, D., Chao, D., Hoffman, H., Kunyk, D., Milen, M., Stewart-Patterson, C., Dick, B., Farnan, P., Straube, S., 2019. Impact of cannabis use on road traffic collisions and safety at work: Systematic review and meta-analysis. *The Canadian Journal of Addiction* 10, 8-15.

ElSohly, M.A., Mehmedic, Z., Foster, S., Gon, C., Chandra, S., Church, J.C., 2016. Changes in cannabis potency over the last 2 decades (1995–2014): Analysis of current data in the United States. *Biological Psychiatry* 79, 613-619.

English, D.R., Holman, C.D.J., Milne, E., Winter, M.G., Hulse, G.K., Codde, J.P., Bower, C.I., Corti, B., de Klerk, N., Knuiman, M.W., Kurinczuk, J.J., Lewin, G.F., Ryan, G.A., 1995. The Quantification of Drug Caused Morbidity and Mortality in Australia, 1995 edition. Commonwealth Department of Human Services and Health, Canberra.

Eszenyi, D., 2017. Annual Review 2016/17. Adelaide, Child Death and Serious Injury Review Committee.

Fasseeh, A., Nemeth, B., Molnar, A., Fricke, F., Horvath, M., Koczian, K., Götze, Á., Kalo, Z., 2018. A systematic review of the indirect costs of schizophrenia in Europe. *European Journal of Public Health* 28, 1043-1049.

Fergusson, D.M., Boden, J.M., 2008. Cannabis use and later life outcomes. *Addiction* 103, 969-978.

Fernández, M., 2012. The socioeconomic impact of drug-related crimes in Chile. *International Journal of Drug Policy* 23, 465-472.

Field, C., 2016. Ombudsman Western Australia Annual Report 2015-16. Perth, Parliamentary Commissioner for Administrative Investigations.

Fiest, K.M., Jette, N., Quan, H., St. Germaine-Smith, C., Metcalfe, A., Patten, S.B., Beck, C.A., 2014. Systematic review and assessment of validated case definitions for depression in administrative data. *BMC Psychiatry* 14, 289.

Fischer, B., Russell, C., Sabioni, P., Van Den Brink, W., Le Foll, B., Hall, W., Rehm, J., Room, R., 2017. Lower-risk cannabis use guidelines: A comprehensive update of evidence and recommendations. *American Journal of Public Health* 107, e1-e12.

Global Burden of Disease Collaborative Network, 2018. Global Burden of Disease Study 2017 (GBD 2017) Results, Institute for Health Metrics and Evaluation, Seattle. Available from http://ghdx.healthdata.org/gbd-results-tool.

Governing the States and Localities, 2019. State marijuana laws in 2019 - map. 4 July 2019. https://www.governing.com/gov-data/safety-justice/state-marijuana-laws-map-medical-recreational.html

Grant, R.L., 2014. Converting an odds ratio to a range of plausible relative risks for better communication of research findings. *British Medical Journal* 348, e1-7.

Gregory, P., 2015. Annual Review 2014-15. Canberra, ACT Children & Young People Death Review Committee.

Grigg, J., Lenton, S., Scott, J., Barratt, M., 2015. Social supply of cannabis in Australia, Monograph series No. 59. Canberra, National Drug Law Enforcement Research Fund.

Gruber, J., Köszegi, B., 2001. Is addiction 'rational'? Theory and evidence. *Quarterly Journal of Economics* 116, 1261-1303.

Gunn, J.K.L., Rosales, C.B., Center, K.E., Nuñez, A., Gibson, S.J., Christ, C., Ehiri, J.E., 2016. Prenatal exposure to cannabis and maternal and child health outcomes: A systematic review and meta-analysis. *BMJ Open* 6, e009986.

Gwynne, C., 2016. Annual Review 2015-16. Darwin, Northern Territory Child Deaths Review and Prevention Committee.

Hall, W., Degenhardt, L., 2009. Adverse health effects of non-medical cannabis use. *The Lancet* 374, 1383-1391.

Hall, W., 2018. The future of the international drug control system and national drug prohibitions. *Addiction* 113, 1210-1223.

Hall, W., Stjepanović, D., Caulkins, J., Lynskey, M., Leung, J., Campbell, G., Degenhardt, L., 2019a. Supplementary appendix Public health implications of legalising the production and sale of cannabis for medicinal and recreational use. *The Lancet* 394, 1580-1590.

Hall, W., Stjepanović, D., Caulkins, J., Lynskey, M., Leung, J., Campbell, G., Degenhardt, L., 2019b. Public health implications of legalising the production and sale of cannabis for medicinal and recreational use. *The Lancet* 394, 1580-1590.

Hall, W., Lynskey, M., 2020. Assessing the public health impacts of legalizing recreational cannabis use: The US experience. *World psychiatry* 19, 179-186.

Han, B., Gfroerer, J.C., Colliver, J.D., Penne, M.A., 2009. Substance use disorder among older adults in the United States in 2020. *Addiction* 104, 88-96.

Hancox, R.J., Shin, H.H., Gray, A.R., Poulton, R., Sears, M.R., 2015. Effects of quitting cannabis on respiratory symptoms. *European Respiratory Journal* 46, 80-87.

Haney, M., Malcolm, R.J., Babalonis, S., Nuzzo, P.A., Cooper, Z.D., Bedi, G., Gray, K.M., McRae-Clark, A., Lofwall, M.R., Sparenborg, S., 2016. Oral cannabidiol does not alter the subjective, reinforcing or cardiovascular effects of smoked cannabis. *Neuropsychopharmacology* 41, 1974-1982.

Hanuš, L.O., Meyer, S.M., Muñoz, E., Taglialatela-Scafati, O., Appendino, G., 2016. Phytocannabinoids: A unified critical inventory. *Natural Product Reports* 33, 1357-1392.

Harris, A.H., Hill, S.R., Chin, G., Li, J.J., Walkom, E., 2008. The role of value for money in public insurance coverage decisions for drugs in Australia: A retrospective analysis 1994-2004. *Medical Decision Making* 28, 713-722.

Hasin, D.S., Sarvet, A.L., Cerdá, M., Keyes, K.M., Stohl, M., Galea, S., Wall, M.M., 2017. US adult illicit cannabis use, cannabis use disorder, and medical marijuana laws: 1991-1992 to 2012-2013. *JAMA Psychiatry* 74, 579-588.

Hickman, M., Taylor, C., Chatterjee, A., Degenhardt, L., Frischer, M., Hay, G., Tilling, K., Wiessing, L., Griffiths, P., McKetin, R., 2002. Estimating the prevalence of problematic drug use: A review of methods and their application. *Bulletin on Narcotics* 54, 15-32.

HM Treasury (UK), 2018. The Green Book: Central Government Guidance on Appraisal and Evaluation. London, HM Treasury.

Independent Hospital Pricing Authority, 2015. National Efficient Price Determination 2015-16. Canberra, Commonwealth of Australia.

Independent Hospital Pricing Authority, 2018. National Hospital Cost Data Collection Cost Report: Round 20 Financial Year 2015-16. Canberra, Commonwealth of Australia.

Institute for Health Metrics and Evaluation, 2019. Global Burden of Disease 2017, GBD Compare Tool. 9 April 2019. https://vizhub.healthdata.org/gbd-compare/,

Jeffreys, H., Hirte, C., Rogers, N., Wilson, R., 2009. Parental Substance Misuse and Children's Entry into Alternative Care in South Australia. Adelaide, Government of South Australia, Department of Families and Communities.

Jiang, R., Lee, I., Lee, T.A., Pickard, A.S., 2017. The societal cost of heroin use disorder in the United States. *PloS One* 12, e0177323.

Jin, H., Mosweu, I., 2017. The societal cost of schizophrenia: A systematic review. *Pharmacoeconomics* 35, 25-42.

Jouanjus, E., Leymarie, F., Tubery, M., Lapeyre-Mestre, M., 2011. Cannabis-related hospitalizations: unexpected serious events identified through hospital databases. *British Journal of Clinical Pharmacology* 71, 758-765.

Jouanjus, E., Lapeyre-Mestre, M., Micallef, J., French Association of the Regional Abuse Dependence Monitoring Centres Working Group on Cannabis Complications, 2014. Cannabis use: signal of increasing risk of serious cardiovascular disorders. *Journal of the American Heart Association* 3, e000638.

Justice and Community Safety Directorate, 2016a. ACT State Budget, 2015-16, Budget Statement. Canberra, ACT Government.

Justice and Community Safety Directorate, 2016b. ACT State Budget, 2016-17, Budget Statement. ACT Government.

Kaar, S.J., Gao, C.X., Lloyd, B., Smith, K., Lubman, D.I., 2015. Trends in cannabis-related ambulance presentations from 2000 to 2013 in Melbourne, Australia. *Drug and Alcohol Dependence* 155, 24-30.

Kendler, K.S., Lönn, S.L., Salvatore, J., Sundquist, J., Sundquist, K., 2018. The origin of spousal resemblance for alcohol use disorder. *JAMA Psychiatry* 75, 280-286.

Kenkel, D.S., 1991. Health behavior, health knowledge and schooling. *Journal of Political Economy* 99, 287-305.

Khashaba, E., El-Helaly, M., El-Gilany, A.H., Motawei, S.M., Foda, S., 2017. Risk factors for non-fatal occupational injuries among construction workers: A case–control study. *Toxicology and Industrial Health* 34, 83-90.

Kniesner, T.J., Viscusi, W.K., Ziliak, J.P., 2010. Policy relevant heterogeneity in the value of statistical life: New evidence from panel data quantile regressions. *Journal of Risk and Uncertainty* 40, 15-31.

Laibson, D., 2001. A cue-theory of consumption. *Quarterly Journal of Economics* 116, 81-119.

Large, M., Nielssen, O., 2017. Daily use of high-potency cannabis is associated with an increased risk of admission and more intervention after first-episode psychosis. *Evidence-Based Mental Health* 20, 58.

Laslett, A.-M., Room, R., Ferris, J., Wilkinson, C., Livingston, M., Mugavin, J., 2011. Surveying the range and magnitude of alcohol's harm to others in Australia. *Addiction* 106, 1603-1611.

Laslett, A.-M., Dietze, P.M., Room, R.G.W., 2013. Carer drinking and more serious child protection case outcomes. *British Journal of Social Work* 43, 1384-1402.

Legal Aid Commission New South Wales, 2016. Annual Report, 2015-16. Sydney, Legal Aid.

Legal Aid Queensland, 2016. Annual Report, 2015-16. Brisbane,

Legal Services Commission of South Australia, 2016. 38th Annual Report, 2015-16. Adelaide, Legal Services Commission.

Leijdesdorff, S., van Doesum, K., Popma, A., Klaassen, R., van Amelsvoort, T., 2017. Prevalence of psychopathology in children of parents with mental illness and/or addiction: An up to date narrative review. *Current Opinion in Psychiatry* 30, 312-317.

Lev-Ran, S., Roerecke, M., Le Foll, B., George, T., McKenzie, K., Rehm, J., 2014. The association between cannabis use and depression: A systematic review and meta-analysis of longitudinal studies. *Psychological Medicine* 44, 797-810.

Levinsohn, E.A., Hill, K.P., 2020. Clinical uses of cannabis and cannabinoids in the United States. *Journal of the Neurological Sciences*, 116717.

Li, G., Baker, S.n.P., Zhao, Q., Brady, J.E., Lang, B.H., Rebok, G.W., DiMaggio, C., 2011a. Drug violations and aviation accidents: Findings from the US mandatory drug testing programs. *Addiction* 106, 1287-1292.

Li, X., Hong, Y., Poston, D., 2011b. Preventing HIV in women: A top priority in China's efforts in fighting AIDS. *AIDS Care* 23, 1-4.

Lin, S.-H., Chen, K.C., Lee, S.-Y., Hsiao, C.-Y., Lee, I.H., Yeh, T.L., Chen, P.S., Lu, R.-B., Yang, Y.K., 2013. The economic cost of heroin dependency and quality of life among heroin users in Taiwan. *Psychiatry Research* 209, 512-517.

Marconi, A., Di Forti, M., Lewis, C.M., Murray, R.M., Vassos, E., 2016. Meta-analysis of the association between the level of cannabis use and risk of psychosis. *Schizophrenia Bulletin* 42, 1262-1269.

Marks, R.E., 1994. Cannabis laws: An analysis of costs. *Drug and Alcohol Review* 13, 341-346.

Massachusetts Health Information Management Association, 2017. Coding Tip: Cannabinoid Hyperemesis Syndrome. 9 March 2020. https://www.mahima.org/coding-tip-cannabinoid-hyperemesis-syndrome/

McKetin, R., McLaren, J., Kelly, E., Hall, W., Hickman, M., 2005. Estimating the number of regular and dependent methamphetamine users in Australia, Technical Report 230. Sydney, National Drug and Alcohol Research Centre, UNSW.

McMillan, J., 2017. Report of Reviewable Deaths in 2014 and 2015 Volume 1: Child Deaths. Sydney, NSW, Ombudsman of New South Wales.

McNeilly, B., Ibrahim, J.E., Bugeja, L., Ozanne-Smith, J., 2010. The prevalence of work-related deaths associated with alcohol and drugs in Victoria, Australia, 2001–6. *Injury Prevention*, 10.1136/ip.2010.027052.

Mental Health Commission, 2015. Drug and Alcohol Office Methamphetamine data extract: 19 10 2015. Perth, Government of Western Australia.

Mental Health Commission, 2016. Annual Report 2015/16. Perth, Government of Western Australia.

Miller, T.R., Hendrie, D., 2011. Economic evaluation of interventions. In: Li, G., Baker, S.P. (Eds.), Injury Research: Theories, Methods, and Approaches. Springer, New York. pp. 641-666.

Monte, A.A., Shelton, S.K., Mills, E., Saben, J., Hopkinson, A., Sonn, B., Devivo, M., Chang, T., Fox, J., Brevik, C., Williamson, K., Abbott, D., 2019. Acute illness associated with cannabis use, by route of exposure: An observational study. *Annals of Internal Medicine* 170, 531-537.

Moore, T.J., 2005. What is Australia's "Drug Budget?" The policy mix of illicit drug related government spending in Australia, Drug Policy Modelling Project Monograph Series. No. 1, Melbourne, Turning Point Alcohol and Drug Centre Inc.

Moore, T.J., 2007. Working estimates of the social costs per gram and per user for cannabis, cocaine, opiates and amphetamines, Drug Policy Modelling Project Monograph Series No. 14, Sydney, National Drug and Alcohol Research Centre, UNSW.

Morgan, A., Althorpe, L., 2014. Short-term cost-benefit model for imprisonment and community corrections in Victoria: Female prisoners and offenders, Consultancy report for Corrections Victoria. Canberra, Australian Institute of Criminology.

Mortimer, D., Segal, L., 2006. Economic evaluation of interventions for problem drinking and alcohol dependence: Do within-family external effects make a difference? *Alcohol and Alcoholism* 41, 92-98.

Murray, C.J., Ezzati, M., Flaxman, A.D., Lim, S., Lozano, R., Michaud, C., Naghavi, M., Salomon, J.A., Shibuya, K., Vos, T., 2012. GBD 2010: Design, definitions, and metrics. *The Lancet* 380, 2063-2066.

Nash, F., 2015. Community Affairs Legislation Committee, 2 June 2015, Official Committe Hansard. Canberra, Commonwealth of Australia.

National Academies of Sciences Engineering Medicine, 2017. The health effects of cannabis and cannabinoids: The current state of evidence and recommendations for research. National Academies Press, Wahington DC.

National Centre for Education and Training on Addiction, 2019a. Secondary analysis of Australian Institute of Health and Welfare's 2016 National Drug Strategy Household Survey (unpublished analysis). National Centre for Education and Training on Addiction, Flinders University.

National Centre for Education and Training on Addiction, 2019b. The National Alcohol and Drug Knowledgebase. National Centre for Education and Training on Addiction, Flinders University, Adelaide. 03/10/19. https://nadk.flinders.edu.au/

National Coronial Information System, 2018. About the data; System manuals. Canberra, NCIS.

National Coronial Information System, 2019a. About the data, Operational Statistics. 9 Jan 2019. https://www.ncis.org.au/about-the-data/operational-statistics/

National Coronial Information System, 2019b. About Data, Explanatory Notes. 25 March 2019. https://www.ncis.org.au/about-the-data/explanatory-note

National Institute for Clinical Excellence, 2004. Guide to the Methods of Technology Appraisal. NICE, UK. 23 May 2019. https://www.gov.uk/government/publications/green-book-supplementary-guidance-health

Nayak, M.B., Patterson, D., Wilsnack, S.C., Karriker-Jaffe, K.J., Greenfield, T.K., 2019. Alcohol's secondhand harms in the United States: New data on prevalence and risk factors. *Journal of Studies on Alcohol and Drugs* 80, 273-281.

Ngui, R., Shanahan, M., 2010. Cannabis use disorder treatment and associated health care costs: NSW 2007, Drug Policy Modelling Program Monograph 20. Sydney, National Drug and Alcohol Research Centre, UNSW.

Nicosia, N., Pacula, R.L., Kilmer, B., Lundberg, R., Chiesa, J., 2009. The economic cost of methamphetamine use in the United States, 2005, Monograph 829. MG-829-MPF/NIDA, Santa Monica, CA, RAND Corporation.

Nogueira, J.M., Rodríguez-Míguez, E., 2015. Using the SF-6D to measure the impact of alcohol dependence on health-related quality of life. *European Journal of Health Economics* 16, 347-356.

Norström, T., Rossow, I., 2014. Cannabis use and violence: Is there a link? *Scandinavian Journal of Public Health* 42, 358-363.

Northern Territory Legal Aid Commission, 2016. Annual Report 2015/2016. Darwin, Legal Aid Commission.

Nourbakhsh, M., Miller, A., Gofton, J., Jones, G., Adeagbo, B., 2019. Cannabinoid hyperemesis syndrome: reports of fatal cases. *Journal of Forensic Sciences* 64, 270-274.

Nutt, D.J., King, L.A., Saulsbury, W., Blakemore, C., 2007. Development of a rational scale to assess the harm of drugs of potential misuse. *The Lancet* 369, 1047-1053.

Office of the Director of Public Prosecutions, 2016. Annual Report, 2015-16. Sydney, ODPP.

Oliva-Moreno, J., Trapero-Bertran, M., Peña-Longobardo, L.M., del Pozo-Rubio, R., 2017. The valuation of informal care in cost-of-illness studies: A systematic review. *Pharmacoeconomics* 35, 331-345.

Orford, J., Velleman, R., Copello, A., Templeton, L., Ibanga, A., 2010. The experiences of affected family members: A summary of two decades of qualitative research. *Drugs: Education, Prevention and Policy* 17, 44-62.
Orford, J., Velleman, R., Natera, G., Templeton, L., Copello, A., 2013. Addiction in the family is a major but neglected contributor to the global burden of adult ill-health. *Social Science and Medicine* 78, 70-77.
Orford, J., 2015. Addiction in the Family: Adult and child family members affected by their relatives' excessive substance use or gambling, Addictions and Lifestyles in Contemporary Europe – Reframing Addictions Policy, Policy Brief No. 6. ALICE RAP project.
Organisation for Economic Cooperation and Development, 2016. OECD Statistical Database, OEDC.Stat.org.
Pacula, R.L., 2010. Examining the impact of marijuana legalization on harms associated with marijuana use, Drug Policy Research Center Working Paper. WR-769-RC, Santa Monica, CA, RAND Corporation.
Patterson, E., Sullivan, T., Ticehurst, A., Bricknell, S., 2018. Drug use monitoring in Australia: 2015 and 2016 report on drug use among police detainees, Statistical Report 04. Canberra, Australian Institute of Criminology.
Payne, J., Gaffney, A., 2012. How much crime is drug or alcohol related? Self-reported attributions of police detainees, Trends and Issues in Crime and Criminal Justice, No. 439. Canberra, Australian Institute of Criminology.
Pearce, D., 2000. Valuing Risks to Life and Health, Paper prepared for the European Commission (DGXI) Workshop on Valuing Mortality and Valuing Morbidity. Brussels,
Personal communication TK, 2015, Cost of non-residential treatment. Shanahan, M.
Pharmaceutical Benefits Scheme, 2016a. 2016 PBS co-payment and safety net amounts. Australian Government, Department of Health, Canberra. 17 Aug 2018. http://www.pbs.gov.au/info/news/2016/01/2016-pbs-co-payment-safety-net-amounts
Pharmaceutical Benefits Scheme, 2016b. Australian Statistics in Medicines 2015. Australian Government Department of Health, Canberra. 16 Aug 2018. http://www.pbs.gov.au/info/statistics/asm/asm-2015
Pharmaceutical Benefits Scheme, 2018a. Pharmaceutical Benefits Schedule Item Reports. Australian Government, Department of Health, Canberra. 16 Aug 2018. http://medicarestatistics.humanservices.gov.au/statistics/pbs_item.jsp
Pharmaceutical Benefits Scheme, 2018b. Pharmaceutical Benefits Schedule Browse by Body System. Australian Government, Department of Health, Canberra. 15 Nov 2018. http://www.pbs.gov.au/browse/body-system
Pharmaceutical Benefits Scheme, 2019. Analysis based on Pharmaceutical Benefits Scheme and Repatriation Pharmaceutical Benefits Scheme Section 85 Supply Data. Australian Government Department of Health. 06 March 2020. http://www.pbs.gov.au/info/statistics/dos-and-dop/dos-and-dop
Phillips, J.A., Holland, M.G., Baldwin, D.D., Gifford-Meuleveld, L., Mueller, K.L., Perkison, B., … Dreger, M., 2015. Marijuana in the Workplace: Guidance for Occupational Health Professionals and Employers. *Workplace Health and Safety* 63, 139-164.
Pidd, K., Kostadinov, V., Roche, A.M., 2015. Do workplace policies work? An examination of the relationship between AOD policies and workers' substance use. *International Journal of Drug Policy* 28, 48-54.
Pidd, K.J., Berry, J.G., Roche, A.M., Harrison, J.E., 2006. Estimating the cost of alcohol-related absenteeism in the Australian workforce: The importance of consumption patterns. *Medical Journal of Australia* 185, 637.
Pointer, S., 2018. Trends in hospitalised injury, Australia 1999–00 to 2014–15, Injury Research and Statistics Series No. 110. Cat. no. INJCAT 190, Canberra, AIHW.

Pointer, S., 2019. Hospitalised injury and socioeconomic influence in Australia, 2015–16, Injury Research and Statistics Series no. 125. Cat. no. INJCAT 205, Canberra, AIHW.

Prichard, J., Payne, J., 2005a. Alcohol, drugs and crime: A study of juveniles in detention, Research and Public Policy Series No. 67. Canberra, Australian Institute of Criminology.

Prichard, J., Payne, J., 2005b. Key findings from the Drug Use Careers of Juvenile Offenders study, Trends and Issues in Crime and Criminal Justice 304. Canberra, Australian Institute of Criminology.

Productivity Commission, 1991. Australia's Gambling Industries. Report no. 10 AusInfo, Canberra, Productivity Commission.

Pyne, J.M., French, M.T., McCollister, K.E., Tripathi, S., Rapp, R., Booth, B., 2008. Preference-weighted health-related quality of life measures and substance use disorder severity. *Addiction* 103, 1320-1329.

Ramirez, M., Bedford, R., Sullivan, R., Anthony, T.R., Kraemer, J., Faine, B., Peek-Asa, C., 2013. Toxicology testing in fatally injured workers: A review of five years of Iowa FACE cases. *International Journal of Environmental Research and Public Health* 10, 6154-6168.

Reece, A.S., 2009. Chronic toxicology of cannabis. *Clinical Toxicology* 47, 517-524.

Rehm, J., Baliunas, D., Brochu, S., Fischer, B., Gnam, W., Patra, J., Popova, S., Sarnocinska-Hart, A., Taylor, B., Adlaf, E., 2006. The costs of substance abuse in Canada 2002. Ottawa, Canadian Centre on Substance Abuse.

Ribeiro, L.I., Ind, P.W., 2016. Effect of cannabis smoking on lung function and respiratory symptoms: a structured literature review. *NPJ Primary Care Respiratory Medicine* 26, 16071-16071.

Riddell, S., Shanahan, M., Roxburgh, A., Degelman, M.L., 2007. The cost of drug-related hospital stays in Australia, 1999–2005, Technical Report Number 258. Sydney, National Drug and Alcohol Research Centre, UNSW.

Ritter, A., McLeod, R., Shanahan, M., 2013. Government drug policy expenditure in Australia - 2009/10, Drug Policy Modelling Project Monograph Series No. 24. Sydney, National Drug and Alcohol Research Centre, UNSW.

Ritter, A., Berends, L., Chalmers, J., Hull, P., Lancaster, K., Gomez, M., 2014. New Horizons: The Review of Alcohol and Other Drug Treatment Services in Australia. Sydney, Drug Policy Modelling Program.

Roche, A.M., Pidd, K., Berry, J.G., Harrison, J.E., 2008. Workers' drinking patterns: The impact on absenteeism in the Australian work-place. *Addiction* 103, 738-748.

Roche, A.M., Pidd, K., Kostadinov, V., 2015. Alcohol- and drug-related absenteeism: A costly problem. *Australian and New Zealand Journal of Public Health*, 10.1111/1753-6405.12414.

Rogeberg, O., Elvik, R., 2016. The effects of cannabis intoxication on motor vehicle collision revisited and revised. *Addiction* 111, 1348-1359.

Rogeberg, O., 2019. A meta-analysis of the crash risk of cannabis-positive drivers in culpability studies—Avoiding interpretational bias. *Accident Analysis and Prevention* 123, 69-78.

Roper, T., Thompson, A., 2006. Estimating the costs of crime in New Zealand in 2003/04. Wellington, New Zealand Treasury.

Safe Work Australia, 2014. Australian Workers' Compensation Statistics 2012–13. Canberra, Safe Work Australia.

Safe Work Australia, 2015. The Cost of Work-related Injury and Illness for Australian Employers, Workers and the Community: 2012–13. Canberra, Safe Work Australia.

Saka, Ö., McGuire, A., Wolfe, C., 2009. Cost of stroke in the United Kingdom. *Age and Ageing* 38, 27-32.

Salize, H.J., Jacke, C., Kief, S., Franz, M., Mann, K., 2013. Treating alcoholism reduces financial burden on care-givers and increases quality-adjusted life years. *Addiction* 108, 62-70.

Sarvet, A.L., Wall, M.M., Fink, D.S., Greene, E., Le, A., Boustead, A.E., Pacula, R.L., Keyes, K.M., Cerdá, M., Galea, S., 2018. Medical marijuana laws and adolescent marijuana use in the United States: A systematic review and meta-analysis. *Addiction* 113, 1003-1016.

Sassi, F., 2006. Calculating QALYs, comparing QALY and DALY calculations. *Health Policy and Planning* 21, 402-408.

Shanahan, M., Hughes, C., McSweeney, T., 2016. Australian police diversion for cannabis offences: Assessing program outcomes and cost-effectiveness, Monograph No. 66. Canberra, National Drug Law Enforcement Research Fund.

Shanahan, M., Hughes, C., McSweeney, T., 2017. Police diversion for cannabis offences: Assessing outcomes and cost-effectiveness. *Trends and Issues in Crime and Criminal Justice*, 1.

Silins, E., Fergusson, D.M., Patton, G.C., Horwood, L.J., Olsson, C.A., Hutchinson, D.M., Degenhardt, L., Tait, R.J., Borschmann, R., Coffey, C., 2015. Adolescent substance use and educational attainment: An integrative data analysis comparing cannabis and alcohol from three Australasian cohorts. *Drug and Alcohol Dependence* 156, 90-96.

Smith, R.G., Jorma, P., Sweeney, J., Fuller, G., 2014. Counting the costs of crime in Australia: A 2011 estimate, Research and Public Policy Series 129. Canberra, Australian Institute of Criminology

Sorensen, C.J., DeSanto, K., Borgelt, L., Phillips, K.T., Monte, A.A., 2017. Cannabinoid hyperemesis syndrome: Diagnosis, pathophysiology, and treatment—a systematic review. *Journal of Medical Toxicology* 13, 71-87.

Stafford, J., Breen, C., 2016. Australian Drug Trends 2016. Findings from the Illicit Drug Reporting System (IDRS), Australian Drug Trends Series No. 163. Sydney, National Drug and Alcohol Research Centre, UNSW.

Steering Committee for the Review of Government Service Provision, 2017a. Volume F: Community Services, Report on Government Services 2017. Canberra, Productivity Commission.

Steering Committee for the Review of Government Service Provision, 2017b. Volume C: Justice, Report on Government Services 2017. Canberra, Productivity Commission.

Steering Committee for the Review of Government Service Provision, 2018a. Volume F: Community Services, Report on Government Services 2018. Canberra, Productivity Commission.

Steering Committee for the Review of Government Service Provision, 2018b. Volume E: Health. Canberra, Productivity Commission.

Steering Committee for the Review of Government Service Provision, 2018c. Volume B: Child Care, Education and Training, Report on Government Services. Canberra, Productivity Commission.

Suranovic, S.M., Goldfarb, R.S., Leonar, T.C., 1999. An economic theory of cigarette addiction. *Journal of Health Economics* 18, 1-29.

Swift, W., Wong, A., Li, K.M., Arnold, J.C., McGregor, I.S., 2013. Analysis of cannabis seizures in NSW, Australia: Cannabis potency and cannabinoid profile. *PloS One* 8, e70052.

Tait, R.J., Caldicott, D., Mountain, D., Hill, S.L., Lenton, S., 2016. A systematic review of adverse events arising from the use of synthetic cannabinoids and their associated treatment. *Clinical Toxicology* 54, 1-13.

Tashkin, D.P., Simmons, M.S., Tseng, C.-H., 2012. Impact of changes in regular use of marijuana and/or tobacco on chronic bronchitis. *COPD: Journal of Chronic Obstructive Pulmonary Disease* 9, 367-374.

Tashkin, D.P., 2013. Effects of marijuana smoking on the lung. *Annals of the American Thoracic Society* 10, 239-247.

Taylor, N., Bareja, M., 2005. 2002 National police custody survey, Technical and Background Paper Series No. 13. Canberra, Australian Institute of Criminology.

Taylor, P., Moore, P., Pezzullo, L., 2008. The Cost of Child Abuse in Australia. Melbourne, Australian Childhood Foundation and Child Abuse Prevention Research Australia.

The Treasurer, 2015. WA State Budget, 2015-16, Budget Statements, Volume 2, Budget Paper No. 2. Perth, Government of Western Australia.

The Treasurer, 2016. Tasmania State Budget, 2015-16, Government Services, Volume 2, Budget Paper No. 2. Hobart, Tasmanian Government.

The Treasurer, 2017. SA State Budget, 2017-18, Volume 1, Budget Paper No. 4., Agency Statements. Adelade, Government of South Australia.
Therapeutic Goods Administration, 2019. Access to medicinal cannabis products. Australian Government Department of Health, Canberra. https://www.tga.gov.au/access-medicinal-cannabis-products-1
Tilling, C., Kro, M., Tsuchiya, A., Brazier, J., van Exel, J., Brouwer, W., 2012. Does the EQ-5D reflect lost earnings? *Pharmacoeconomics* 30, 47-61.
Transport Accident Commission, 2016. Annual Report 2015/16. Melbourne, TAC.
Turnbull, M., Keenan, M., Nash, F., 2015. A new action plan to tackle ice Prime Minister's Office. Canberra, Commonwealth of Australia.
United Nations Office of Drugs and Crime, 2019. World Drug Report 2019: Cannabis and Hallucinogens. No E.19.XI.9, Vienna, United Nations.
United Nations Office of Drugs and Crime, 2020. World Drug Report: 3 Drug Supply. Sales No. E.20.XI.6, Vienna, United Nations Publications.
US Department of Health and Human Services, 2006. The Health Consequences of Involuntary Exposure to Tobacco Smoke. Atlanta, GA, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health.
US Department of Transportation, 2015. Revised departmental guidance 2014: Treatment of the value of preventing fatalities and injuries in preparing economic analyses Guidance on Treatment of the Economic Value of a Statistical Life (VSL). Washington, DC, Office of the Secretary of Transportation.
US National Cancer Institute and World Health Organization, 2016. The economics of tobacco and tobacco control, National Cancer Institute Tobacco Control Monograph 21. NIH Publication No. 16-CA-8029A, Bethesda, MD and Geneva, CH, U.S. Department of Health and Human Services, National Institutes of Health, National Cancer Institute; and World Health Organization.
Vardon, C., 2016. Annual Report: Deaths of children and young people, Queensland, 2015 - 16. Brisbane, Queensland Family and Child Commission.
Vaucher, J., Keating, B.J., Lasserre, A.M., Gan, W., Lyall, D.M., Ward, J., Smith, D.J., Pell, J.P., Sattar, N., Paré, G., Holmes, M.V., 2018. Cannabis use and risk of schizophrenia: a Mendelian randomization study. *Molecular Psychiatry* 23, 1287-1292.
Verstraete, A.G., Legrand, S.-A., 2014. Drug use, Impaired Driving and Traffic Accidents. Luxembourg: Publications Office of the European Union, European Monitoring Centre for Drugs and Drug Addiction.
Victoria Legal Aid, 2016. Annual Report 2015-16. Melbourne, Victoria.
Victoria Police, 2014. Crime Statistics 2013/2014. Melbourne, Victoria Police.
Victoria State Government, 2017. Cannabis Hyperemesis Syndrome or hyperemesis - cannabinoid induced. 9 March 2020. http://remote.health.vic.gov.au/viccdb/view.asp?Query_Number=3225
Victorian Government, 2016. Child protection additional service delivery data 2015-16. Melbourne, Department of Health and Human Services
Viscusi, W.K., Aldy, J.E., 2003. The value of a statistical life: A critical review of market estimates throughout the World. *Journal of Risk and Uncertainty* 27, 5-76.
Volkow, N.D., Baler, R.D., Compton, W.M., Weiss, S.R., 2014. Adverse health effects of marijuana use. *New England Journal of Medicine* 370, 2219-2227.
Vos, T., Abajobir, A.A., Abate, K.H., Abbafati, C., Abbas, K.M., Abd-Allah, F., Abdulkader, R.S., Abdulle, A.M., Abebo, T.A., Abera, S.F., GBD 2016 Disease and Injury Incidence and Prevalence Collaborators, 2017. Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. *The Lancet* 390, 1211-1259.
Wadsworth, E.J.K., Moss, S.C., Simpson, S.A., Smith, A.P., 2006. A community based investigation of the association between cannabis use, injuries and accidents. *Journal of Psychopharmacology* 20, 5-13.

Western Australian Police, 2014. Questions on Notice No A7, Standing Committee Estimates and Financial Operations Committee. Perth, WA, Parliament.wa.gov.au.

Whetton, S., O'Neil, M., Halim, S.A., Li, S.Q., Skov, S., 2013. Harms from and Costs of Tobacco Consumption in the Northern Territory. Adelaide, SA, Menzies School of Health Research.

Whetton, S., Shanahan, M., Cartwright, K., Duraisingam, V., Ferrante, A., Gray, D., Kaye, S., Kostadinov, V., McKetin, R., Pidd, K., Roche, A., Tait, R.J., Allsop, S., 2016. The Social Costs of Methamphetamine in Australia 2013/14, Tait, R.J., Allsop, S. (Eds.). Perth, WA, National Drug Research Institute, Curtin University.

Whetton, S., Tait, R.J., Scollo, M., Banks, E., Chapman, J., Dey, T., Halim, S.A., Makate, M., McEntee, A., Muhktar, A., Norman, R., Pidd, K., Roche, A., Allsop, S., 2019. Identifying the Social Costs of Tobacco Use to Australia in 2015/16, Tait, R.J., Allsop, S. (Eds.). Perth, Australia, NDRI.

Whetton, S., Tait, R.J., Chrzanowska, A., Donnelly, N., McEntee, A., Muhktar, A., Zahra, E., Campbell, G., Degenhardt, L., Dey, T., Abdul Halim, S., Hall, W., Makate, M., Norman, R., Peacock, A., Roche, A., Allsop, S., 2020. Quantifying the Social Costs of Pharmaceutical Opioid Misuse and Illicit Opioid Use to Australia in 2015/16, Tait, R.J., Allsop, S. (Eds.). ISBN 978-0-6487367-0-7, Perth, WA, National Drug Research Institute, Curtin University.

World Health Organization, 2000. International Guide for Monitoring Alcohol Consumption and Related Harm. MSD/MSB/00.4, Geneva, WHO, Department of Mental Health and Substance Dependence.

World Health Organization, 2018. International Classification of Diseases 11th Revision. Available at: https://icd.who.int/browse11/l-m/en, Geneva, WHO.

Wundersitza, L., Konstadb, A., 2017. Drug Driving: Analysis of current trends in South Australia. Australasian Road Safety Conference, Perth, WA. p. 12.

NDRI

national drug research institute

ndri.curtin.edu.au