Identifying the Social Costs of Tobacco Use to Australia in 2015/16

National Drug Research Institute, Curtin University

May 2019

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EXECUTIVE SUMMARY

Introduction

In the twentieth century the tobacco epidemic killed an estimated 100 million people globally; in the twenty-first century it may kill one billion people (World Health Organization, 2008). The scientific evidence is clear: smoking causes significant adverse impacts on human health, and the main driver of continued consumption of tobacco by smokers is nicotine dependence. The purpose of this study was to update the estimated social costs of tobacco use in Australia given the changing prevalence of smoking, the length of time since the last national estimate was conducted (for 2004/05 (Collins and Lapsley, 2008)), and new evidence on tobacco caused conditions and costs of tobacco outside the health domain.

The tobacco epidemic, although past its peak in Australia in terms of the prevalence of smoking, still extracts a considerable toll on the health and economic welfare of Australians. Given that there were approximately 2.4 million daily smokers at the time of the 2016 National Drug Strategy Household survey, this scale of harm could be expected to continue for some time if prevalence is not reduced considerably. From the international evidence, we identified 46 conditions wholly or partially caused by active smoking, three where it was protective and nine conditions caused by involuntary or secondhand smoking, with the harms from the caused conditions substantially outweighing the benefits from the prevented conditions. In twelve months (financial year 2015/16) there were 20,032 deaths from smoking-related causes in Australia and there were about 1.7 million smoking-related hospital inpatient episodes.

Net tangible costs of smoking in 2015/16 were estimated to be $19.2 billion (range $16.3 billion to $24.0 billion). The tangible costs in the calculation included the reduction in economic output due to premature mortality, hospital separation costs, other medical and social care costs including the cost of informal care provided by family and friends, costs arising from workplace absenteeism and presenteeism, and spending on tobacco by dependent smokers.

In addition to the tangible costs of smoking, there are very significant intangible costs (e.g. the value of life lost, pain and suffering), both from premature mortality and from the lost quality of life of those experiencing smoking attributable ill-health. These intangible costs of smoking were estimated at $117.7 billion in 2015/16 (range $52.0 billion to $375.8 billion) with the total cost of smoking being $136.9 billion (range $68.3 billion to $399.7 billion) (see Summary Table 1 and Summary Figure 1).

The most significant individual cost item within the tangible costs was the spending on tobacco by dependent smokers, which was estimated at $5.5 billion, followed by workplace costs ($5.0 billion) and the reduction in the present value of future economic output due to premature mortality ($3.4 billion). Other health costs were also estimated and these included outpatient treatment, specialist care and possible excess general practitioner visits. Further, we developed an estimate of informal carer costs, which is the unpaid care provided by family members to those with smoking-related conditions.

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 (Chapter 4)	4,045,343,309	4,045,343,309	4,045,343,309
Avoided healthcare costs (Chapter 4)	-2,275,922,187	-2,275,922,187	-
Healthcare (Chapters 5 and 6)	6,787,191,713	4,926,406,396	8,143,292,217
Other workplace costs (Chapter 7)	4,985,357,708	4,003,870,310	6,039,946,435
Other tangible costs (Chapter 8)	5,701,263,430	5,648,714,854	5,727,941,138
Total tangible costs	**19,243,233,973**	**16,348,412,682**	**23,956,523,099**
Intangible costs			
Intangible cost of premature mortality (Chapter 4)	92,108,544,749	49,058,706,233	272,906,689,958
Intangible cost of smoking attributable ill-health (Chapter 9)	25,562,393,635	2,937,793,265	102,880,616,235
Total intangible costs	**117,670,938,384**	**51,996,499,498**	**375,787,306,193**
TOTAL COSTS	**136,914,172,357**	**68,344,912,180**	**399,743,829,292**

[a] High and low values were not calculated for all domains: may not sum due to rounding

In addition to these costs, smokers and society incur costs in terms of 'gap' and over-the-counter payments and expenses to the Pharmaceutical Benefit Scheme (PBS) for medications to treat smoking-related illness. We quantified the costs of medications for several smoking-related conditions identified in the top 50 most expensive and the 50 most frequently prescribed items on the PBS. Clearly, many other medications and smoking-related conditions that we did not include would similarly contribute to the total medication costs attributable to smoking. In addition, costs were estimated for smoking cessation products such as nicotine replacement therapy. Overall costs to the non-inpatient health system were estimated at nearly $3.2 billion plus a further $2.0 billion in costs arising from the provision of informal care.

Recognising the extent of premature mortality from smoking-related conditions, we identified nearly $2.3 billion in reductions in future health expenditures as a result of these early deaths. Premature deaths are a net negative for Australia both from an ethical perspective, and from a health costs perspective, as even after these partially offsetting cost savings, the net impact of smoking on health and social care is to increase costs by $4.5 billion.

The use of tobacco also results in costs to employers, through lost productivity from both increased levels of absenteeism by smokers and reduced (health-related) performance while at work. Some analyses have included a further cost for smoking breaks during the working day (ICF International, 2016a), but there were insufficient data on Australian workplaces to enable a reliable estimate of this deficit to be made. Nevertheless, we calculated that lost workplace productivity costs from absenteeism and presenteeism amounted to $5.0 billion in 2015/16, with further productivity losses from premature death captured within the costs of the mortality estimate ($3.4 billion).

Cigarettes are an ignition source for both building and landscape fires. The introduction of reduced-ignition propensity cigarettes in 2010 was intended to result in a reduction, particularly to domestic residential fires, caused by accidentally discarded cigarettes. Nevertheless, there were still 474 structural fires where cigarettes were identified as the source of ignition at an estimated cost of $80.8 million. We

identified a total of over 4500 fires of all types caused by cigarettes, but we were unable to allocate a cost for the large majority of these, in particular for landscape fires.

The last national cost estimate for Australia was unable to quantify costs of removing smoking-related litter (Collins and Lapsley, 2008). Subsequent international and Australian State-based studies have quantified the costs of litter removal. Using the same methods would result in a national figure of $100 million: we used this as our upper estimate and used a more conservative approach in calculating a figure of $73.3 million for our central estimate for the target year. However, we recognise that this does not capture all costs, for example, injuries to, and death of, wildlife, and the loss of amenity for those exposed to a littered environment.

Exclusions

Government revenue from tobacco was estimated but not included, as revenue items are a transfer of resources, rather than a net cost arising from tobacco use *per se*. We also did not include the cost of, education, research and prevention programs in that these are based on policy decisions, rather than tobacco use – an approach used in previous studies (Collins and Lapsley, 2008). The status of 'quitline' services is more ambiguous with respect to their contribution to treatment or prevention/education: the costs of quitline services were estimated, but not included in the total.

Limitations

Across all areas, the economic cost of tobacco use had to be estimated from data that are collected for other purposes and values then attributed to events and outcomes. Each type of outcome was associated with an unknown level of uncertainty, both in attributing it to tobacco use and in relation to the costs assigned to it. Where possible we have developed a plausible range together with a central estimate. For example, while we rely on a single estimate for the number of deaths due to smoking, in estimating the intangible costs of premature mortality, we provided a low and high range based on different evaluations of the 'value' of a life. We provide relevant details when ranges are calculated.

Conclusions

In 2015/16, there were 20,032 premature deaths attributable to smoking, roughly 1.7 million hospital separations, $19.2 billion in tangible costs and $117.7 billion in intangible costs of smoking. From a policy perspective, harms accrued from smoking in previous decades continue to have impact today, and this report reinforces the need to continue to invest in strategies to prevent and reduce smoking and the associated significant morbidity and mortality.

The final 'headline' cost in the current study of $136.9 billion appears to be significantly greater than the last national estimate of $31.5 billion for 2004/05 [1] (Collins and Lapsley, 2008). However, this difference is primarily driven by different assumptions and epidemiological approaches, particularly in relation to the estimation of the intangible costs of premature mortality, where our estimate was $117.7 billion compared with $19.5 billion. If one were to apply current values for years of life lost to Collins and Lapsley's estimate of the years of life not lived due to smoking, then the 2004/05 intangible cost of mortality would have been $105.8 billion. These differences are explored in Chapter 11 and summarised in Table 11.2. The

[1] CPI adjusted to December 2015 $41.9 billion (Australian Bureau of Statistics, 2016c)

estimates of tangible costs in this study total $19.2 billion in 2015/16 compared to Collins and Lapsley's estimate of $12 billion in 2004/05 [2].

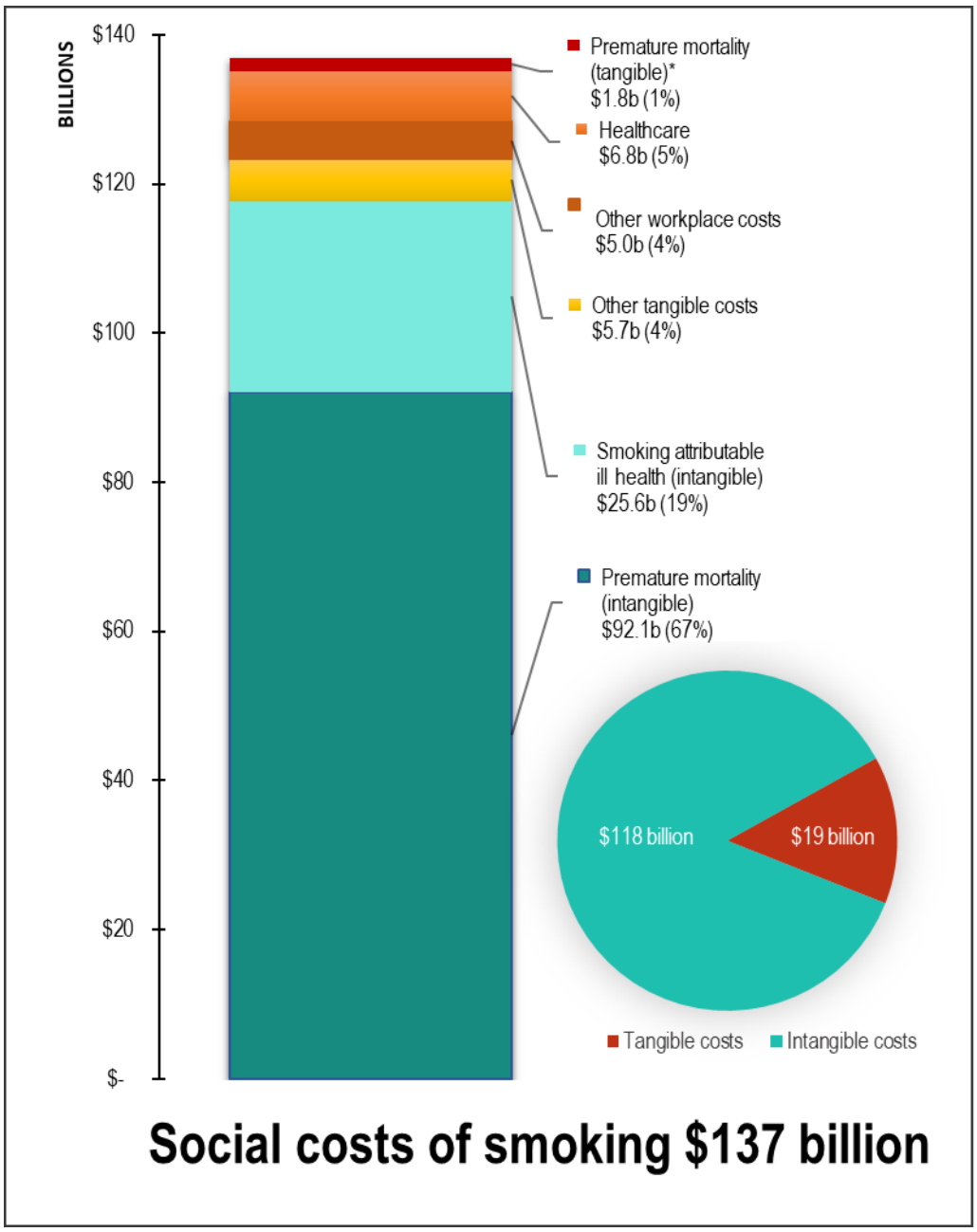
This analysis did not try to replicate the method used previously in Australia, instead it drew on the international literature to identify a current and more widely used method. The costs cannot therefore be directly compared with previous Australian findings, but represent the current understanding of the extent of harms and costs due to smoking. Cost comparisons between countries are likely to be more problematic than comparisons over time within a jurisdiction, due to the different cost structures (e.g., in the provision of health care) and in purchasing power parity, in addition to the assumptions underpinning the analysis. However, an analysis of smoking-related costs in 27 European Union countries reported that the cost of smoking-related diseases accounted for 6.2 per cent of health spending (range 3.6 % to 11.9 %) (SANCO, 2009). These values are broadly consistent with the 4.4 per cent of health-care costs accounted for in Australia.

The current study identified new cost areas that were not included in the previous estimate (e.g. the contribution to society of informal care, intangible costs of ill-health, and the cost of litter), new conditions attributable to smoking were added to the list of adverse health outcomes (e.g. type 2 diabetes, liver cancer, reduced fertility, rheumatoid arthritis, orofacial clefts and stroke due to secondhand smoke), and the extent of smoking's contribution to a number of conditions has been updated. More recent research has resulted in the adoption of different parameters for intangible costs, and the ageing of the Australian population, and the increase in the population, has seen many of the health impacts of smoking become more significant since 2004/05 (for example net smoking attributable deaths have increased from 14,901 in 2004/05 to 20,032 in 2015/16). These changes have significantly contributed to the higher overall cost of smoking in the current study.

Despite the considerable progress in reducing the prevalence of smoking in recent decades, this report highlights the continuing toll of smoking in Australia, to individuals, to families, and to society more generally.

[2] CPI adjusted to December 2015 $16.0 billion (Australian Bureau of Statistics, 2016c)

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



Summary Figure 2: Infographic

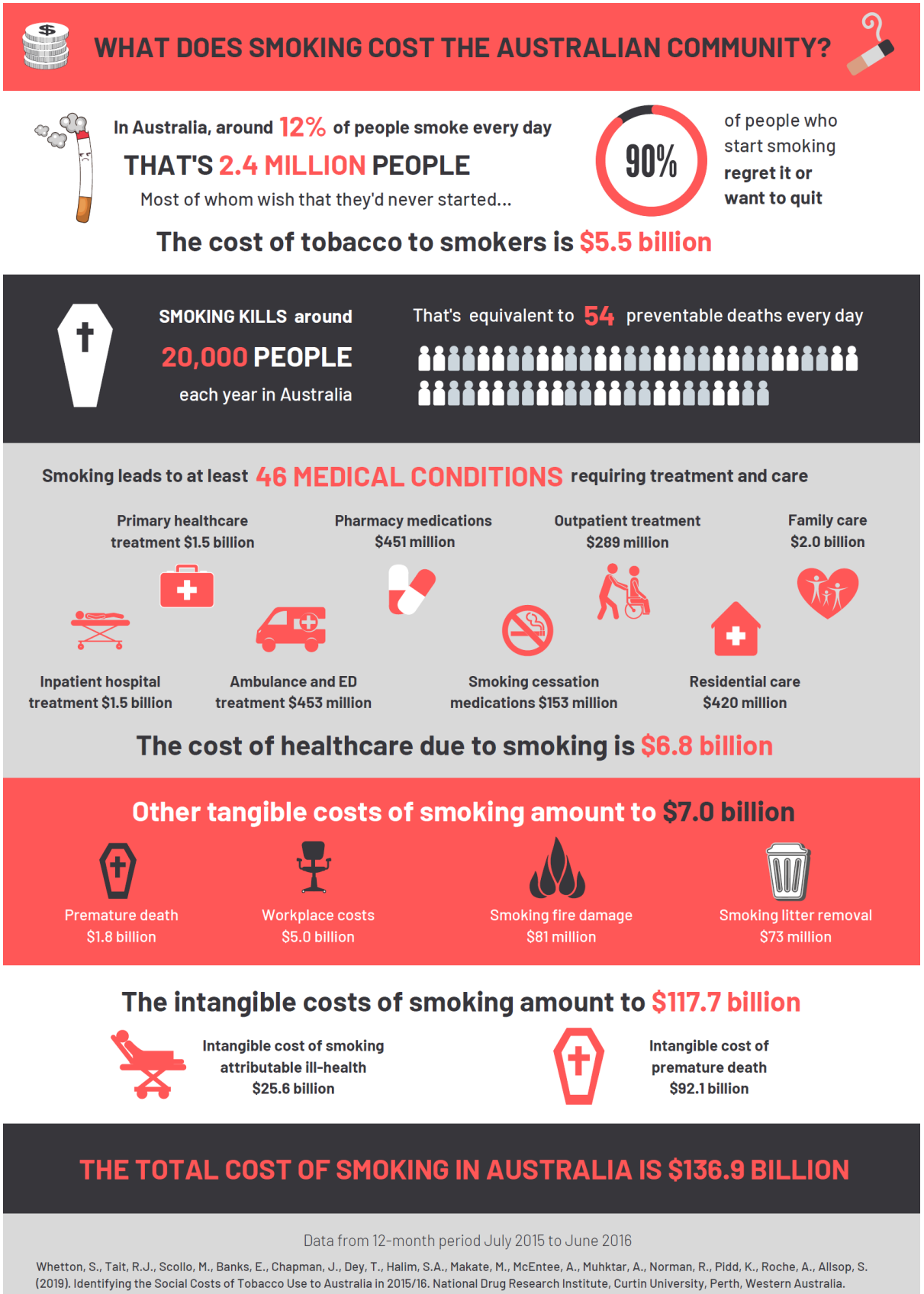


Table of contents

Contents

Table of tables

Table of figures

CHAPTER 1: INTRODUCTION

Steve Whetton, Michelle Scollo, Marshall Makate, Robert J. Tait, Tania Dey, Emily Banks, Richard Norman, Aqif Muhktar, Ken Pidd, Ann Roche & Steve Allsop

1.1 Rationale

The National Drug Research Institute at Curtin University was contracted by the Australian Government Commonwealth Department of Health to undertake this research into the costs of tobacco use to Australia, in collaboration with a multi-disciplinary team of researchers.

The overarching objective was to produce as comprehensive as possible an estimate of the costs of tobacco use to Australian society. In Australia, most people who use tobacco do so in the form of manufactured, 'tailor made' cigarettes or roll-your-own cigarettes, with fewer than 1 per cent of daily smokers reporting either use of cigars or pipes or water pipes (Australian Institute of Health and Welfare, 2017a). While all forms of tobacco use are eligible for inclusion, data, and in particular data on harms, may not specify the manner in which tobacco is consumed. The current report excludes any data specifically relating to e-cigarettes ('vaping') (see Section 11.3.4).

The remainder of Chapter 1 provides a brief overview of tobacco use, with a particular focus on the Australian context. Chapter 2 provides an account of the methods that were used in the current study and the rationale for the decisions made in selecting the approach (also see appendix Chapter 2.1 for further details). Chapter 3 addresses the derivation of attributable fractions for conditions partially caused by smoking. Chapter 4 focuses on tobacco-related deaths and uses data from the Australia Institute of Health and Welfare (AIHW) to estimate the number of premature deaths and the associated costs. Chapter 5 again draws on the AIHW datasets, this time focusing on hospital separations to estimate costs of tobacco-related inpatient morbidity. Chapter 6 addresses primary care and non-admitted or out-of-hospital health costs, including emergency department and outpatient care, ambulance costs, general practitioner / specialist treatment, nursing home care, medication costs including cessation products and other medication costs of treating tobacco-related illness. We also estimated avoided health care costs to provide an overall net figure. Chapter 7 investigates the impact of tobacco use on the workplace. Chapter 8 provides an estimate of other tangible costs (tobacco purchased by dependent smokers, fires arising from smoking and the costs of removing smoking-related litter). Chapter 9 examines the intangible costs of smoking-related morbidity. Chapter 10 investigates the revenue derived from tobacco products and also lists the areas excluded from the costing process. Chapter 11 provides an overall summary of the report and a comparison with the last national analysis (Collins and Lapsley, 2008). Finally, some key areas for future research are explored. In addition, a separate report has been produced which provides a systematic review of tobacco cost of illness studies, including international and multi-national findings (Makate et al., 2019) (see appendix Chapter 1.1).

1.2 Background

In the twentieth century the tobacco epidemic killed an estimated 100 million people globally; in the twenty-first century it may kill one billion people (World Health Organization, 2008). The scientific evidence is very clear that smoking causes significant adverse impacts on human health, and that the main driver of continued consumption of tobacco by smokers is nicotine dependence. For example, the main conclusions of the 2010 US Surgeon General's report were:

"The scientific evidence supports the following major conclusions:

1. The evidence on the mechanisms by which smoking causes disease indicates that there is no risk-free level of exposure to tobacco smoke.
2. Inhaling the complex chemical mixture of combustion compounds in tobacco smoke causes adverse health outcomes, particularly cancer and cardiovascular and pulmonary diseases, through mechanisms that include DNA damage, inflammation, and oxidative stress.
3. Through multiple defined mechanisms, the risk and severity of many adverse health outcomes caused by smoking are directly related to the duration and level of exposure to tobacco smoke.
4. Sustained use and long-term exposures to tobacco smoke are due to the powerfully addicting effects of tobacco products, which are mediated by diverse actions of nicotine and perhaps other compounds, at multiple types of nicotinic receptors in the brain.
5. Low levels of exposure, including exposures to secondhand tobacco smoke, lead to a rapid and sharp increase in endothelial dysfunction and inflammation, which are implicated in acute cardiovascular events and thrombosis" (US Department of Health and Human Services, 2010, p.9).

Worldwide, tobacco is estimated to cause seven million deaths annually, which equates to more than 10 per cent of global deaths; greater than the combined mortality from tuberculosis, HIV/AIDS and malaria (World Health Organization, 2015). The World Health Organization, as part of its Framework Convention on Tobacco Control documentation, rejects the tobacco industry's argument that the production and sale of tobacco products provide overall benefits to society (Zafeiridou et al., 2018). Currently the global social and economic cost of tobacco is estimated to be over one trillion (US) dollars per year (Eriksen et al., 2015). In Australia, the most recent national estimate put the social cost of tobacco at $31.5 billion[3] in 2004/05 across both tangible and intangible costs and estimated that there were 14,901 deaths attributable to tobacco (Collins and Lapsley, 2008).

The 2016 Australian Burden of Disease study ranked smoking as the largest single contributing risk factor, accounting for 9 per cent of the total burden (Australian Institute of Health and Welfare, 2016b). The relative impact of risk factors identified varied by sex and age-group. For males, tobacco was the leading risk for those aged 45 to 94 years, and for females it was the leading risk factor for those aged 45 to 84 years (Australian Institute of Health and Welfare, 2016b). The harms of tobacco are concentrated in respiratory diseases, cancers, cardiovascular disease and endocrine disorders. Tobacco has a high mortality rate amongst its users, with 76 per cent of the lost disability adjusted life years (DALYs) due to premature mortality (Australian Institute of Health and Welfare, 2016b). In Australia, the most recent direct estimates are that up to two-thirds of deaths among current smokers can be attributed to smoking, with around a 10-year loss of average life expectancy (Banks et al., 2015). Cessation reduces mortality compared with those who continue to smoke, with earlier cessation resulting in greater improvements (Banks et al., 2015).

The prevalence of smoking in Australia has reduced substantially in the late twentieth and early twenty-first century. Figure 1.1 shows the overall prevalence of daily smoking over time in Australia and highlights some of the legislative changes over the period. Notable declines in the prevalence of daily smoking (from 50 % of Aboriginal and Torres Strait Islander adults who smoked daily in 2004-05 to 41 % in 2013-14 (Lovett et al., 2017) means that the majority of the Aboriginal and Torres Strait Islander population do not smoke. In 2011, tobacco was the single largest contributor to the gap in fatal disease burden between Aboriginal and Torres Strait Islander and non-Aboriginal and Torres Strait Islander Australians (Australian

[3] Unless otherwise stated, costs in this report are in Australian dollars.

Institute of Health and Welfare, 2016c). Other groups where the rate of smoking is much higher than the general population include those with mental health disorders and those with other drug dependence (Cooper et al., 2012; Guydish et al., 2016). It is reported that smoking is the largest contributory factor in the 10-20 year difference in life expectancy for those with mental health conditions compared to the general population (Harker and Cheeseman, 2016; Lawrence et al., 2013).

The general reduction in the prevalence of tobacco has not translated into an immediate reduction in all the adverse health effects due to the long lag-time of some conditions (e.g. cancers), the increasing population size and the ageing of the population, and in particular the ageing of the population of smokers and former smokers. Indeed, the number of deaths is estimated to have increased over this period. In 2003 there were an estimated 15,000 deaths per year due to smoking (Begg et al., 2007), while in 2011 the number of deaths was estimated at 18,762 (Australian Institute of Health and Welfare, 2016b). Alternative estimates, using a different methodology, put the number of deaths attributable to tobacco in Australia at 22,900 in 2010 and 24,000 in 2015 (Peto et al., 2015). Declines in exposure to secondhand smoke and smoking while pregnant (Australian Institute of Health and Welfare, 2016a, b) are likely to have more rapidly reduced some of the short lead-time adverse impacts of smoking such as low birthweight and Otitis media. However, with approximately 2.4 million daily smokers at the time of the 2016 National Drug Strategy Household Survey, smoking will continue to generate significant costs over the long-term, unless prevalence can be reduced further.

Figure 1.1: Daily tobacco smoking, people aged 14 years or older, selected years, 1977 to 2016 (per cent) with key tobacco control measures implemented in Australia

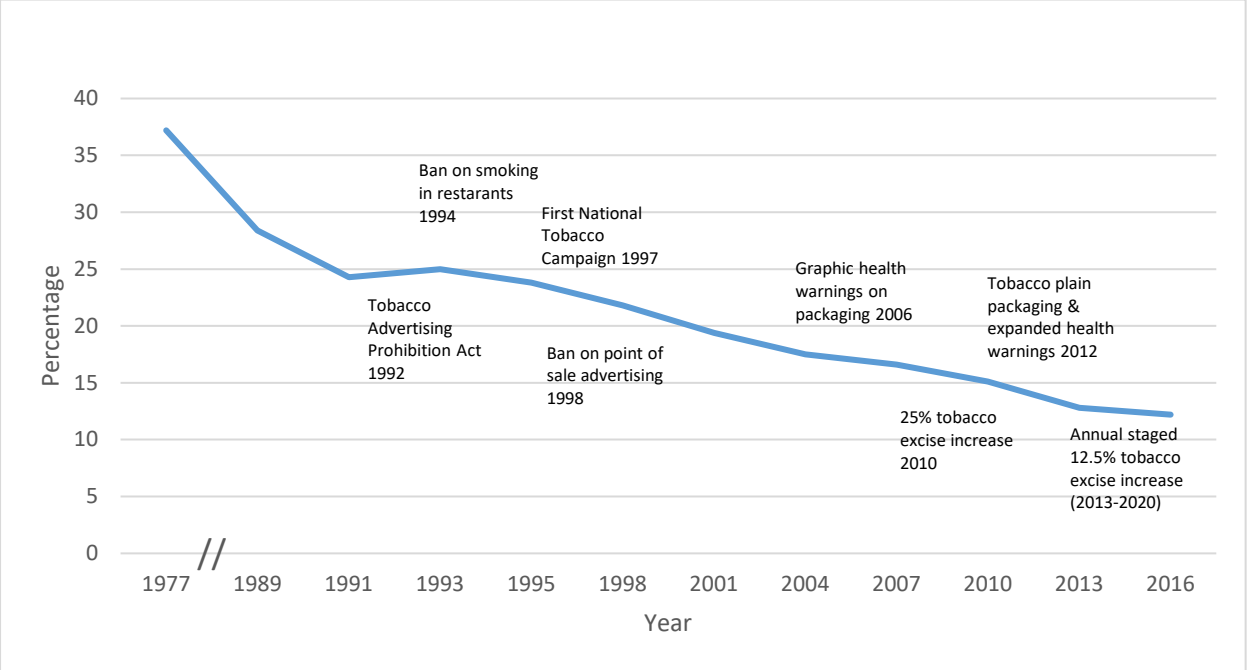


Figure adapted from the Department of Health: Tobacco Control key facts and figures (2017): additional prevalence data from Australian Bureau of Statistics (1977), Alcohol and Tobacco Consumption Patterns Survey; 1989-90 (1994) and National Drug Strategy Household Survey (Australian Institute of Health and Welfare, 2017a, d)

1.3 Previous Australian social cost estimates

Within the Australian context, the estimation of tobacco-related social costs has been dominated by the work of Collins and Lapsley. Tables 1.1 and 1.2 provide summaries of the costs both from a national perspective and for some States and Territories. In Table 1.1 we have included the 2004 adjusted values using the change in the CPI (Australian Bureau of Statistics, 2016c). However, it is important to recognise that there is considerable disparity in the rate of increase in some economic sectors, with health costs likely to outstrip the general CPI increase in prices (Jacobs et al., 2014).

Table 1.1: Previous Australian national estimates of the social costs of tobacco

Report	Year	Tangible $(000,000)	Intangible $(000,000)	Total $(000,000)	2004 values total $(000,000) [2]
Collins & Lapsley 1991 (Collins and Lapsley, 1996)	1988 [1]	4,929.1	4,817.8	9,746.9	16,113.0
Collins & Lapsley 1996 (Collins and Lapsley, 1996)	1992	6,537.6	6,198.6	12,736.2	17,386.9
Collins & Lapsley 2002 (Collins and Lapsley, 2002)	1998/99	7,586.7	13,476.3	21,063.0	25,319.1
Collins & Lapsley 2008 (Collins and Lapsley, 2008)	2004/05	12,026.2	19,459.7	31,485.9	n/a

[1] The initial analysis for 1988 reported a total cost of $6841.5m (Collins and Lapsley, 1991): the 1996 analysis used an updated methodology for both 1988 and 1992 (Collins and Lapsley, 1996).
[2] Adjusted using the ABS consumer price index inflation calculator to December 2004 values (Australian Bureau of Statistics, 2016c)

Table 1.2: Previous Australian State or Territory estimates of the social costs of tobacco

Report	Location	Year	Tangible $(000,000)	Intangible $(000,000)	Total $(000,000)	Cost per capita $[1]
Collins & Lapsley 2006 (Collins and Lapsley, 2006)	Vic	1998/99	1,593.6	3,456.3	5,049.9	1,094
Collins & Lapsley 2010 (Collins and Lapsely, 2010)	NSW	2006/07	2,940.8	5,458.2	8,399.0	1,238
Whetton 2013 (Whetton et al., 2013)	NT	2005/06	209.3	554.3	763.6	3,682
Collins & Lapsley 2014 (Collins and Lapsely, 2014)	WA	2009/10	1,259.2	1,697.4	2,956.6	1,306

[1] Total costs were divided by the relevant total population at the mid-time point of the estimate: Victoria 1989/99 4,617,308: NSW 2006/07 6,786,160: NT 2005/06 207,385: WA 2009/10 2,263,747 (Australian Bureau of Statistics, 2018a)

In comparing the costs between States or Territories, not only is there the issue of inflation, but also the differences in population size and the prevalence of smoking. Figure 1.1 shows the decline in the prevalence of smoking nationally, but for the States and Territories in Table 1.2, the prevalence of daily smoking in 2014/15 ranged from 13.7 per cent in Victoria to 20.9 per cent in the Northern Territory (Australian Bureau of Statistics, 2015b). The adjusted total in Table 1.2 provides a rough approximation of the relative scale of harm by dividing the total cost by the total States or Territory population at the date of the estimate to give the cost per adult in each jurisdiction.

1.4 Conclusions

We drew on this existing Australian evidence on the social cost of tobacco use and the broader international works (detailed in a separate systematic review undertaken as part of this investigation (Makate et al., 2019)) in framing the current analysis. The details of the methodology, the conditions and costs considered eligible for inclusion are addressed in Chapters 2 and 3.

CHAPTER 2: METHODS

Steve Whetton, Michelle Scollo, Robert J. Tait, Tania Dey, Emily Banks, Marshall Makate, Aqif Muhktar, Richard Norman, Ken Pidd, Ann Roche & Steve Allsop

2.1 Background

Social cost studies attempt to quantify, in monetary terms, the total costs of a disease, condition or behaviour. They are typically used as a policy tool to identify high-cost areas and for public health advocacy. This type of study may comprise a diverse range of costs including: treatment costs; other healthcare costs; lost productivity; other tangible costs (e.g. fires); and, intangible costs (e.g. the intangible costs of premature death).

Studies estimating the cost of a particular drug or activity need first of all to decide:

- On what costs are to be included in the study—social costs and private costs or social costs alone, and if so, how these costs are to be defined; and,
- On the timeframe of costs to be examined—costs in a single year of current and historical use, or costs of current use including effects on current and future costs.

Once the scope of the study is determined it then needs to identify:

- Estimates on the prevalence of use, ideally by level of potential harm;
- Evidence on the nature of harms that are wholly or partially caused by the drug and the share of that harm that can be attributed to the drug;
- Data sources to estimate all the relevant costs stemming from the harms caused and the definition of costs; and,
- The unit cost of the harms.

2.2 Approach to economic analysis

2.2.1 Private and social costs

It is generally accepted that studies of the social costs or costs of illness should exclude any net private costs borne by the individual themselves. This is because it is assumed that consumers will only purchase a good or service if the benefits they expect to gain from it more than offset the expected costs (including any expected non-financial costs such as increased risk of ill-health). (Cost benefit studies will include all of the purely private costs but they will also attempt to quantify the increase in utility arising from the use of the substance).

Whilst there is a consensus for this approach for “normal” goods and services, there is considerable debate on how such studies should treat those costs incurred by users with a drug dependence, as decisions to consume such drugs are not necessarily rational and fully informed. A good review of the literature on this issue is included in Cawley and Ruhm (Cawley and Ruhm, 2011), and the discussion in this section draws on their work. Some economists maintain that, even for those drugs that have the potential to cause dependence, harms borne by the substance user themselves should not be considered in assessing public policy. This is what is known as the ‘rational addiction’ hypothesis, which was first set out in Becker and Murphy (1988) (see Appendix Chapter 2.1 for further details) and has been an influential model informing social cost studies for drugs of dependence. This hypothesis essentially proposes that users take the risk of dependence into account when they decide to consume the substance, and that dependence is best thought of as something that increases the benefits users receive

from consuming the substance. As such any costs borne by the user should be excluded from economic analyses such as social cost studies.

However, findings from empirical work with those consuming drugs of dependence potentially undermine many of the core assumptions underpinning the 'rational addiction' model, suggesting that consumers generally:

- Underestimate how likely they are to become dependent on the drug (Gruber and Köszegi, 2001; Kenkel, 1991);
- Hold incomplete information on the potential health impacts of consuming the drug in question, and in particular underestimate the potential impacts on themselves (Gruber and Köszegi, 2001; Kenkel, 1991; Khwaja et al., 2007; Smith et al., 2008; US Department of Health and Human Services, 1994);
- Have different preferences for the product over their lifetime (for example holding positive views about smoking when first consuming tobacco but later wishing they had never started (Angeletos et al., 2001; Gruber and Köszegi, 2001; Laibson, 2001)); and,
- Making decisions based on 'rules of thumb', and using incomplete information, rather than fully considering the potential impacts of decisions (Akerlof, 1991; Suranovic et al., 1999).

These departures from the standard 'rational consumer' model mean that at least some of the costs arising from dependence can justify public policy responses to reduce consumption to its optimal level for the user once all costs are fully taken into account. (U.S. National Cancer Institute and World Health Organization, 2016) This could involve, but is not limited to, decreasing availability, increasing price, or providing information to users and potential users.

Following this rationale, whilst costs to a dependent user are not strictly social costs, in that they are borne by the users themselves, they have not been included (or have only been partially included) in consumption decisions, and therefore cannot necessarily be assumed to have delivered an equal or greater benefit to the consumer to offset their costs. Such costs are often referred to as 'internalities'; costs to the user that were not factored into their consumption decision. Internality theory postulates that government policies should include both internal and external costs, such that changes in taxation levels can be justified even when there are no external costs, as such, interventions ensure that consumers are taking these costs into account in their decision making (U.S. National Cancer Institute and World Health Organization, 2016).The question then arises as to how, if at all, these costs should be included in a social cost study.

There is no consensus in the literature on the preferred approach to take to these 'internalities':

- Many social cost studies continue to exclude costs borne by the substance users themselves either because the authors consider the 'rational addiction' hypothesis to still be a useful framework, or due to the difficulty in identifying what net costs borne by the user should be included as a social cost;
- Another approach that is often taken is to include only those costs to consumers regarded as most closely related to dependent use (potentially including their expenditure induced by dependence), or where imperfect information is regarded as particularly significant (e.g. costs related to premature mortality) but to disregard costs incurred by non-dependent users. For example, Collins and Lapsley (2008) included the intangible costs of premature mortality of all substance users, and the expenditure by dependent users on the drug of dependence; and,

- The final approach taken is to treat all costs borne by ***dependent*** users as social costs on the basis that few of the core assumptions of the rational consumer model are met in the case of drugs of dependence, and that continued use amongst dependent users is primarily driven by the dependence rather than by well-informed rational decisions. Costs borne by non-dependent users are still typically excluded from the social cost calculation.

Given the evidence on the degree to which cigarettes use amongst daily smokers is highly associated with dependence, and self-reported desire to quit (and to have never have started smoking), the current study adopts the latter approach, and includes all costs borne by dependent smokers. For the purposes of the analysis, dependent smokers have been defined as daily smokers (see the discussion in Section 2.3.1).

2.2.2 Timeframe

The choice of study year will ideally be as close to the present time as possible, but this is subject to the availability of key data. Mortality data in particular are only available with a lag as in some cases the recording of the cause of death needs to be deferred until the conclusion of investigations by the coroner's office in the relevant jurisdiction or the conclusion of criminal or other proceedings. The most recent financial year for which reliable cause of death data were available at the time of submitting data requests to the AIHW, the custodians of the data, in mid-2018 was 2015/16, and so this was adopted as the study year. As detailed below, the smoking behaviours associated with these costs could have occurred years or even decades earlier.

2.2.3 Approaches to estimating cost

Consistent with previous studies commissioned by the Australian Government, which quantified the costs of smoking in the years 1988, 1992, 1998/9, and 2004/5 (Collins and Lapsley, 1996, 2002, 2008), this study attempted to quantify the costs of smoking that are related to one particular recent year of interest (financial year 2015/16).

Two broad approaches[4] can be taken to assessing the costs related to a particular study year for a social cost study:

(a) Valuing the marginal impact of smoking in the study year on all future harms of smoking (with these future costs converted back to present value terms using an appropriate discount rate). This approach, sometimes called the incidence approach requires 'damage functions' for all relevant smoking attributable forms of illness and premature mortality so that the increase in the probability of illness and death in each future year due to smoking in 2015/16 can be calculated; or,

(b) Valuing the costs incurred in the study year from the harms that occur in that year, regardless of when the smoking that led to that harm occurred. This approach, sometimes called the prevalence approach, calculates the quantum of all forms of smoking attributable harm occurring in the study year and converts these estimates to monetary values. Where harm that occurs in the study year has costs borne in future years (for example the lost economic output arising from premature

[4] 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 smoking 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 workforce in the study year). This approach was not used for the current study as, in our opinion, the epidemiological data on historical smoking attributable deaths was not of sufficient quality.

mortality) this future stream of costs is estimated and needs to be discounted back to present values using an appropriate discount rate.

Each approach has advantages and disadvantages. The incidence approach (future costs of harms arising from exposure in the study year) is preferred where the objective of the social cost calculation is to support analysis of the potential impact of policy change (e.g. incorporating avoided costs into a cost benefit analysis of a new treatment for dependence). The incidence approach also has the advantage that all of the measured harm arises from new 'flows' of harm, whereas the prevalence approach, because some of the harms are the result of prolonged exposure and others are the result of acute reactions to current use, mixes 'stock' and 'flow' measures of harm.

The prevalence approach is preferred if the objective is to identify the resources required to address harms caused by the substance in the study year (for example, if the focus of the study is on the costs to government), or if the stream of lifetime costs is uncertain (if, for example, 'damage functions' are not available for all of the relevant harms), or where the lag times between exposure and the harm occurring is uncertain.

In the case of the social cost of smoking, the epidemiological data needed to calculate damage functions, and make assumptions about the distribution of lags between exposure and harms, is only available for a few of the forms of smoking attributable ill-health. Therefore, we have adopted a prevalence approach in this study. Where possible to be consistent with this prevalence approach we have adopted 'stock' measures of cost, for example the smoking attributable costs of formal and informal care for those who have suffered a stroke is included for the stock of those receiving care for impairment arising from a stroke, regardless of when the stroke occurred. The one exception to this is premature mortality where we have included the present value of all future costs of smoking attributable deaths that occurred in the study year.

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

The current study aimed to estimate the net social costs of smoking for the year 2015/16. To do this we first needed estimates for that year of the number of people who died and the number of episodes of hospital and other health care that might be attributed to smoking. We also needed an estimate of the number of people who could be classified as dependent smokers. We then identified the costs in 2015/16 of health care, absenteeism, fires and litter arising from current and historical tobacco use. We quantified spending on tobacco products by tobacco users in 2015/16, excluding the spending assumed to be undertaken freely, voluntarily, and having taken into account all of the costs, by non-dependent smokers (defined as people who smoked less than daily). We estimated the intangible costs to those smokers who in 2015/16 were suffering disability, pain and other reductions to quality of life due to smoking-attributable disease. Finally we estimated the long term future costs of lost productivity as well as the avoided health care costs associated with the smoking attributable deaths estimated to have occurred in 2015/16, as well as the intangible value of those deaths.

2.3 Epidemiological basis for cost calculations

2.3.1 Which smokers are included?

While theoretically one might wish to exclude the costs borne 'voluntarily' by smokers who are not dependent, who freely 'choose' to continue smoking, in practical terms it is very difficult to distinguish

such smokers in household surveys, and therefore to quantify how many such smokers exist in the Australian population. Some smokers now smoke fewer than five cigarettes per day during the working week, but still smoke many cigarettes at the weekend and may still meet some of the other criteria for dependence. In addition, a small percentage of people are non-daily smokers, with 1.3 per cent reporting occasional - less than daily and 1.4 per cent occasional – less than weekly use (Australian Institute of Health and Welfare, 2017a). Overall, the old threshold of 5 cigarettes a day adopted by Collins and Lapsley in earlier reports may no longer be the most appropriate indicator of dependence. Almost all smokers (90 %) report that they regret ever having started to smoke, and are unhappy about their inability to quit (Fong et al., 2004; Pechacek et al., 2017). Most smokers in Australia (70 % Table 3.36 (Australian Institute of Health and Welfare, 2017a)) report that intend to quit in the short to medium term, but the majority of these will experience (sometimes multiple) failed attempts to quit, with not all succeeding. Of those who do not intend to give up, about 40 per cent give reasons such as 'I've tried to quit before and it hasn't worked' and 'I'm addicted to nicotine' indicating they believe themselves unable to quit. Of the 18 per cent of smokers who say that they enjoy smoking too much to quit, (60 per cent of the 30 per cent of smokers who say they do not intend to quit) many of these would also be classified as dependent and would also experience significant challenges in quitting.

Whilst this survey evidence may suggest that those smoking less frequently than daily should be included in the social cost analysis, to be consistent with the general literature and reflecting that the relative risks are typically reported for daily smokers or converted to the equivalent of daily smokers (or historic rates of daily smokers for longer lag conditions) the analysis of costs used in this report is based on data associated only with daily smokers (GBD 2015 Tobacco Collaborators, 2017b).

2.3.2 Prevalence of smoking

Smoking affects not only the smoker themselves, but also those exposed to secondhand smoke, for example in the home and in the workplace (generally most workplace exposure is historic as smoking is now banned in virtually all workplaces with just a few exceptions such as 'high-roller' rooms in casinos and outdoor drinking areas in hotels in some States and Territories). Prevalence data are required not only on smokers but also others exposed to secondhand smoke.

High quality data on prevalence of smoking by age-group are available from the National Drug Strategy Household Survey (NDSHS) both for the current year (2016) and for five-year lagged rates (NDSHS 2010) (Australian Institute of Health and Welfare, 2011, 2017d) (see 2.3.3 for a discussion of the use of prevalence data in the epidemiological calculations). The NDSHS is a triennial survey collecting respondent's attitudes to, and behaviours around, alcohol, tobacco and illicit drugs which is managed by the Australian Institute of Health and Welfare.

As the NDSHS does not reliably capture Aboriginal and Torres Strait Islander smoking prevalence, Aboriginal and Torres Strait Islander specific prevalence rates were calculated from the National Aboriginal and Torres Strait Islander Social Survey (NATSIS) confidentialised unit record file (Australian Bureau of Statistics, 2016f).

Data on rates of smoking inside the home for households with another adult or with one or more children resident were calculated from the NDSHS 2016 and NDSHS 2010 unit record files (Australian Institute of Health and Welfare, 2017e). Data on smoking amongst pregnant women were sourced from the AIHW National Perinatal Data Collection (Australian Institute of Health and Welfare, 2018b).

2.3.3 Lag time for harms

The prevalence of smoking in the current year cannot be used to estimate the proportion of many of the smoking related harms that can be attributed to smoking. Data on current smoking prevalence (or the prevalence from five years ago) are not sufficient as tobacco is a relatively unusual substance of concern, in that the majority of the morbidity and mortality arising from its use occurs a considerable time after consumption starts. If the prevalence of use had been stable over time this would not affect the approach to the analysis, however smoking prevalence has been subject to significant changes over time (see Figure 1.1).

If the lag structure between exposure and morbidity or mortality was well defined then it might be possible to create condition-specific prevalence rates from historical data. However, robust data on the expected timeframe between exposure and morbidity or mortality is not available for most conditions. The analysis also faces the problem that historical data on exposure to secondhand tobacco smoke in the workplace (and even the home) are very limited.

The solution adopted to the time lag issue is to use a method, developed by Peto *et al.,* in which an artificial estimate of smoking prevalence is used based on a comparison of the rate of lung cancer mortality amongst smokers in the population of interest with that of smokers and never smokers in a reference population (Peto et al., 1992). The reference population used in this method is that described in the American Cancer Society Cancer Prevention Study (CPS)-II study - a large, long-term follow-up study in the United States (Garfinkel, 1985). Based on this method, an artificial measure of past smoking prevalence, called the smoking impact ratio (SIR), can be calculated as follows (Ezzati and Lopez, 2003):

$$SIR = \frac{C_{LC} - N_{LC}}{S^*_{LC} - N^*_{LC}} \times \frac{N^*_{LC}}{N_{LC}}$$

where:

C_{LC}: (age-group and sex-specific) lung cancer mortality rate in the study population (e.g. country of analysis)

N_{LC}: (age-group and sex-specific) lung cancer mortality rate of never-smokers in the same population

S^*_{LC} is the age-group and sex specific lung cancer mortality rate of smokers in the reference population

N^*_{LC} is the age-group and sex specific lung cancer mortality rate of never smokers in the reference population.

Where the SIR is greater than 1 it is corrected to 1, and where the SIR is less than 0 it is corrected to 0.

Typically the reference population used is that of the American Cancer Prevention Study II (CPS-II) study.

Lung cancer rates in never-smokers are very low and studies of populations large enough to measure them have been rarely performed; therefore the 'never smoker' lung cancer mortality risk is often not available for the study population. Where it is available, there has been little difference from the rates observed in the American CPS II study. Therefore, in most studies in developed economies, data on never smokers from the CPS-II study are also used as a proxy for never smokers in the study population (Ezzati and Lopez, 2003).

For this study, SIRs were calculated separately for men and women, and for Aboriginal and Torres Straits Islander and non-Aboriginal and Torres Straits Islander persons.

The SIRs were used as a synthetic prevalence estimate instead of current self-reported smoking prevalence rates for those conditions with a long lag-time (all cancers and for Chronic Obstructive Pulmonary Disease (COPD)) to calculate AFs using the formula set out in Section 3.2.

For those conditions with moderate lag times we followed Gakidou et al. and used the prevalence of smoking five years prior to the study year (e.g. smoking prevalence data from the NDSHS 2010 (Australian Institute of Health and Welfare, 2011)) (Gakidou et al., 2017; GBD 2015 Tobacco Collaborators, 2017a).

For those conditions caused by acute exposure, including perinatal and antenatal exposure, current smoking prevalence rates for the relevant population were used.

Table 3.1 identifies the conditions for which the SIRs were used as a prevalence estimate, as well as those using current and 5-year lagged smoking prevalence from the NDSHS.

2.3.4 Causal factors and potentially causal factors

Tobacco use is a causal factor for numerous health conditions. Smoking has been demonstrated to have a partially protective effect for three conditions (Parkinson's disease, hypertension in pregnancy and endometrial cancer). For most conditions it increases the risk of disease. For a limited number of conditions it is the sole causal factor, while for other conditions, smoking is one of several (or many) potentially causative factors.

Conditions caused entirely by smoking

Conditions related to tobacco use can only be caused by tobacco, and so the following conditions have an AF of one:

- Mental and behavioural disorders due to use of tobacco;
- Tobacco dependence; and,
- Toxic effect: Tobacco and nicotine.

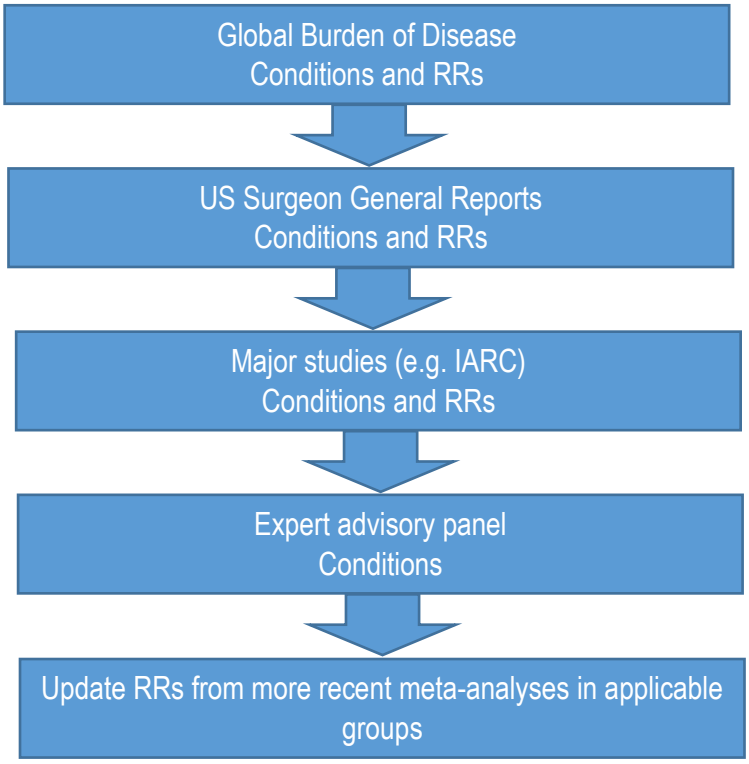
Smoking as one of several causes

The starting point for identifying conditions partially caused or prevented by smoking was the most recent Global Burden of Disease study (Gakidou et al., 2017; GBD 2015 Tobacco Collaborators, 2017a). We then reviewed the US Surgeon General's reports on smoking (US Department of Health and Human Services, 2004, 2006, 2014), reports from the International Agency for Research on Cancer (IARC) (International Agency for Research on Cancer, 2012), and the Australian Research Council Working Group on the Evaluation of Carcinogenic Risks to Humans. The input of the advisory panel was sought on the completeness of the list and the identification of any recent meta-analyses with updated relative risk estimates (see figure 2.1). Finally, there were two conditions where the US Surgeon General's reports up to 2014 have classified the condition as "suggestive but not sufficient to infer a causal relationship" where we believe the evidence is now sufficient to justify inclusion, due to additional analyses published since the latest US Surgeon General's report (miscarriage) or where we believe the evidence presented in the US Surgeon General's reports is in fact strong enough to merit inclusion (adolescent asthma caused by direct smoking).

Joint causation

The issue of joint causation with other substances is relatively minor for smoking compared to many other substances, particularly illicit drugs. However, there are a small number of harms where joint causation needs to be considered. Firstly fires attributable to smoking (with the soporific effect of alcohol and certain other substances also being potential causal factors in ignition). Second, peptic ulcers (smoking exacerbates the impact of H Pylori rather than being a primary causal factor in its own right (Ridolfo and Stevenson, 2001)), and thirdly in the case of lung cancer and asbestosis, smokers exposed to asbestos are more likely to develop the conditions than either smokers alone or those exposed to asbestos (World Health Organization, 2013). The first two potential sources of joint causation were controlled for in the studies drawn on for attributable fractions. We were not able to identify sufficient quality estimates of the interaction between exposure to asbestos and smoking on lung cancer, and thus our estimates of lung cancer attributable to smoking are likely to be modestly underestimated.

Figure 2.1: Flow chart: Identification of conditions wholly or partially caused by tobacco smoking and the sources of the associated relative risk (RR) estimates



2.4 Excluded items

As with earlier cost of illness studies (Collins and Lapsley, 2008), we have not included revenue from excise and customs duty but quantify these separately in Chapter 10. Spending on Quit campaigns and other educational and policy initiatives to discourage uptake or encourage cessation is determined in explicit decisions by Governments and is not determined automatically by the number of people smoking or the incidence of diseases caused by smoking. Other than PBS subsidies for anti-smoking medicines prescribed to assist smokers cope with withdrawing from tobacco products during a quit attempt, spending on anti-smoking measures is not therefore included in this analysis. The cost of Government

efforts to avert evasion of customs duty on imported tobacco products and control of unlicensed domestic production is also excluded from this analysis for similar reasons (see Chapter 10 for more details).

CHAPTER 3: ESTABLISHING SMOKING ATTRIBUTABLE FRACTIONS

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3.1 Conditions and risks

Following the selection process outlined in Section 2.3.4, a number of conditions affecting smokers which have been linked to smoking through meta-analyses, and for which the evidence is sufficiently robust to support their inclusion in the analysis, were identified (English et al., 1995; Gakidou et al., 2017; GBD 2015 Tobacco Collaborators, 2017a; International Agency for Research on Cancer, 2012; US Department of Health and Human Services, 2004, 2006, 2014). The conditions are listed below, with further details provided in Table 3.1:

- Tuberculosis;
- Ischaemic heart disease;
- Ischaemic stroke;
- Haemorrhagic stroke;
- Hypertensive heart disease;
- Atrial fibrillation and flutter;
- Aortic aneurysm;
- Peripheral vascular disease;
- Other cardiovascular and circulatory diseases;
- Asthma is causal among adolescents. For adults smoking is only causally linked to exacerbation of existing asthma, however this results in increased risk of hospitalisation and death (Gilliland et al., 2006; US Department of Health and Human Services, 2014, Table 4.3 p77);
- Peptic ulcer disease;
- Diabetes mellitus, but only type 2 (US Department of Health and Human Services, 2014, p544);
- Rheumatoid arthritis;
- Cataracts;
- Macular degeneration;
- Erectile dysfunction ((US Department of Health and Human Services, 2014, Table 4.4, p84), in particular due to “arterial insufficiency and corporovenous occlusion” ICD N52.03);
- Reduced fertility in women (US Department of Health and Human Services, 2014, Table 4.4 p83);
- Lip and oral cavity cancer;
- Nasopharynx cancer;
- Cancer of nasal cavity and accessory sinuses (International Agency for Research on Cancer, 2012, p 116);
- Oesophageal cancer;
- Stomach cancer;
- Colon and rectum cancer;
- Pancreatic cancer;
- Larynx cancer;
- Tracheal, bronchus, and lung cancer;
- Kidney cancer;
- Bladder cancer;
- Acute myeloid leukaemia;
- Cervical cancer;

- Liver cancer;
- Chronic obstructive pulmonary disease;
- Interstitial lung disease and pulmonary sarcoidosis;
- Other chronic respiratory diseases;
- Influenza and pneumonia;
- Hip Fracture;
- Non-Hip Fracture;
- Fire injuries;
- Antepartum haemorrhage;
- Premature rupture of membranes;
- Ectopic pregnancy;
- Stillbirth;
- Hypertension in pregnancy (protective effect);
- Endometrial cancer (protective effect); and,
- Parkinson's disease (protective effect).

In addition, there are a number of conditions caused by exposure to secondhand tobacco smoke (or exposure to smoking during pregnancy). Those conditions for which the evidence for the impact of secondhand smoke, or exposure to smoking in utero is regarded as strong enough to include in the study are:

- Low birthweight;
- Sudden Infant Death Syndrome (SIDS);
- Asthma (children);
- Lower respiratory illness (children);
- Otitis media (children);
- Oro-facial clefts;
- Lung cancer attributable to secondhand tobacco smoke;
- Ischaemic heart disease attributable to secondhand tobacco smoke; (US Department of Health and Human Services, 2006) and,
- Cerebrovascular disease attributable to secondhand tobacco smoke (US Department of Health and Human Services, 2014, Table 4.7 pg 91).

Finally, there are a number of conditions for which the evidence is inadequate or merely suggestive of a link with tobacco smoking, so that it is currently not strong enough to demonstrate a causal link (English et al., 1995; US Department of Health and Human Services, 2014). Our approach is to exclude from the current study the following conditions for which there is a potential link to smoking:

- Anal cancer;
- Vulvar cancer;
- Ovarian cancer. A combination of causal and protective effects, combined with limitations in the ICD-10 coding structure which in the Australian hospital separations data and in the Australian mortality data cannot differentiate these subtypes, means that it is not possible to identify the proportion of ovarian cancer that should be attributed to smoking.[5];
- Penile cancer;

[5] Current evidence suggests that: smoking is a risk factor for invasive mucinous and borderline mucinous ovarian tumours; former smoking increased the risk of borderline serous ovarian tumours; smoking appears to have no impact on the risk of developing invasive serous and endometrioid ovarian cancer, and that smoking has a potentially protective effect against invasive clear cell ovarian cancer (Faber et al., 2013).

- Carcinoma in situ (respiratory);
- Crohn's disease;
- Ulcerative colitis (in the past smoking had been thought to have a protective effect for ulcerative colitis up to the publication of the 2004 US Surgeon General's report (US Department of Health and Human Services, 2004), however it is now determined that there is unlikely to be a causal relationship (US Department of Health and Human Services, 2014));
- Periodontitis (smoking is a risk factor for some forms of periodontitis (US Department of Health and Human Services, 2014, Table 4.5 p 87), however the necrotising version of periodontitis is caused by HIV-AIDS and similar immune suppressing diseases and smoking is not a risk factor. Currently available data does not make it possible to distinguish between necrotising periodontitis and other forms of periodontitis, and as such we have not been able to identify the proportion of periodontitis attributable to smoking;
- Breast cancer (secondhand smoke);
- Cervical cancer (secondhand smoke); and,
- Nasal-sinus cancer (secondhand smoke).

Table 3.1 sets out, for each of the conditions included in this study, the age specific relative risks of exposure to tobacco smoke (whether from own smoking or secondhand smoke) the source of the relative risk estimates and the exposure prevalence relative to the specific condition.

Table 3.1: Causal relationships between smoking and health conditions (relative risks)

Condition	Source	ICD -10 codes	Exposure	Sex	Relative risk by age															
					0 years	1-5 years	5-14 years	15-19 years	20-24 years	25-29 years	30-34 years	35-39 years	40-44 years	45-49 years	50-54 years	55-59 years	60-64 years	65-69 years	70-74 years	75-79 years	80+ years
Tuberculosis	a	A15, A16, A19, B90	5 year lag	M							1.588	1.588	1.588	1.588	1.588	1.588	1.588	1.588	1.588	1.588	1.588
Tuberculosis	a	A15, A16, A19, B91	5 year lag	F							1.599	1.599	1.599	1.599	1.599	1.599	1.599	1.599	1.599	1.599	1.599
Lip and oral cavity cancer	a	C00-C09, C14	SIR	M							8.162	8.162	8.162	8.162	8.162	8.162	8.162	8.162	8.162	8.162	8.162
Lip and oral cavity cancer	a	C00-C09, C14	SIR	F							6.056	6.056	6.056	6.056	6.056	6.056	6.056	6.056	6.056	6.056	6.056
Nasopharynx cancer	a	C10-C13	SIR	M							8.227	8.227	8.227	8.227	8.227	8.227	8.227	8.227	8.227	8.227	8.227
Nasopharynx cancer	a	C10-C13	SIR	F							6.089	6.089	6.089	6.089	6.089	6.089	6.089	6.089	6.089	6.089	6.089
Oesophageal cancer	a	C15	SIR	M							6.676	6.676	6.676	6.676	6.676	6.676	6.676	6.676	6.676	6.676	6.676
Oesophageal cancer	a	C15	SIR	F							6.357	6.357	6.357	6.357	6.357	6.357	6.357	6.357	6.357	6.357	6.357
Stomach cancer	a	C16	SIR	M							1.927	1.927	1.927	1.927	1.927	1.927	1.927	1.927	1.927	1.927	1.927
Stomach cancer	a	C16	SIR	F							1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57
Colon and rectum cancer	a	C18-C20	SIR	M							1.325	1.325	1.325	1.325	1.325	1.325	1.325	1.325	1.325	1.325	1.325
Colon and rectum cancer	a	C18-C20	SIR	F							1.418	1.418	1.418	1.418	1.418	1.418	1.418	1.418	1.418	1.418	1.418
Liver cancer	b	C22	SIR	M							1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Liver cancer	b	C22	SIR	F							1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Pancreatic cancer	a	C25	SIR	M							2.506	2.506	2.506	2.506	2.506	2.506	2.506	2.506	2.506	2.506	2.506
Pancreatic cancer	a	C25	SIR	F							2.098	2.098	2.098	2.098	2.098	2.098	2.098	2.098	2.098	2.098	2.098
Cancer of nasal cavity	c	C30	SIR	M							4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Cancer of nasal cavity	c	C30	SIR	F							4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Cancer of accessory sinuses	c	C31.8	SIR	M							4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Cancer of accessory sinuses	c	C31.8	SIR	F							4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Larynx cancer	a	C32	SIR	M							14.60	14.60	14.60	14.60	14.60	14.60	14.60	14.60	14.60	14.60	14.60
Larynx cancer	a	C32	SIR	F							14.60	14.60	14.60	14.60	14.60	14.60	14.60	14.60	14.60	14.60	14.60
Tracheal, bronchus, and lung cancer	a	C33-C34	SIR	M							22.51	22.51	22.51	22.51	22.51	22.51	22.51	22.51	22.51	22.51	22.51
Tracheal, bronchus, and lung cancer	a	C33-C34	SIR	F							14.09	14.09	14.09	14.09	14.09	14.09	14.09	14.09	14.09	14.09	14.09
Cervical cancer	a	C53	SIR	F							1.679	1.679	1.679	1.679	1.679	1.679	1.679	1.679	1.679	1.679	1.679

Condition	Source	ICD -10 codes	Exposure	Sex	Relative risk by age															
					0 years	1-5 years	5-14 years	15-19 years	20-24 years	25-29 years	30-34 years	35-39 years	40-44 years	45-49 years	50-54 years	55-59 years	60-64 years	65-69 years	70-74 years	75-79 years	80+ years
Endometrial cancer (protective)	b, d	C54.1	SIR	F											0.71	0.71	0.71	0.71	0.71	0.71	0.71
Kidney cancer	a	C64-C65	SIR	M							2.293	2.293	2.293	2.293	2.293	2.293	2.293	2.293	2.293	2.293	2.293
Kidney cancer	a	C64-C65	SIR	F							1.518	1.518	1.518	1.518	1.518	1.518	1.518	1.518	1.518	1.518	1.518
Bladder cancer	a	C66-C67	SIR	M							3.332	3.332	3.332	3.332	3.332	3.332	3.332	3.332	3.332	3.332	3.332
Bladder cancer	a	C66-C67	SIR	F							2.582	2.582	2.582	2.582	2.582	2.582	2.582	2.582	2.582	2.582	2.582
Acute myeloid Leukaemia	a	C92	SIR	M							2.013	2.013	2.013	2.013	2.013	2.013	2.013	2.013	2.013	2.013	2.013
Acute myeloid Leukaemia	a	C92	SIR	F							1.163	1.163	1.163	1.163	1.163	1.163	1.163	1.163	1.163	1.163	1.163
Diabetes mellitus type 2	a	E11	5 year lag	M							1.426	1.426	1.426	1.426	1.426	1.426	1.426	1.426	1.426	1.426	1.426
Diabetes mellitus type 2	a	E11	5 year lag	F							1.102	1.102	1.102	1.102	1.102	1.102	1.102	1.102	1.102	1.102	1.102
Parkinson's disease (protective)	b	G20	5 year lag								0.570	0.570	0.570	0.570	0.570	0.570	0.570	0.570	0.570	0.570	0.570
Cataract	a	H25-H26	5 year lag	Both							1.671	1.671	1.671	1.671	1.671	1.671	1.671	1.671	1.671	1.671	1.671
Macular degeneration	a	H35.3	5 year lag	Both							1.911	1.911	1.911	1.911	1.911	1.911	1.911	1.911	1.911	1.911	1.911
Hypertensive heart disease	a	I11	5 year lag	M							4.153	3.785	3.451	3.146	2.868	2.616	2.386	2.176	1.985	1.811	1.578
Hypertensive heart disease	a	I11	5 year lag	F							4.11	3.74	3.405	3.102	2.826	2.576	2.35	2.144	1.957	1.787	1.56
Ischaemic heart disease	a	I20-I25	5 year lag	M							4.316	3.924	3.569	3.246	2.952	2.685	2.443	2.223	2.023	1.841	1.598
Ischaemic heart disease	a	I20-I25	5 year lag	F							6.145	5.464	4.859	4.321	3.843	3.417	3.039	2.703	2.404	2.139	1.794
Atrial fibrillation and flutter	a	I48	5 year lag	M							4.153	3.785	3.451	3.146	2.868	2.616	2.386	2.176	1.985	1.811	1.578
Atrial fibrillation and flutter	a	I48	5 year lag	F							4.11	3.74	3.405	3.102	2.826	2.576	2.35	2.144	1.957	1.787	1.56
Other cardiovascular and circulatory diseases	a	I46-I47, I49-I52, I77-I79	5 year lag	M							4.153	3.785	3.451	3.146	2.868	2.616	2.386	2.176	1.985	1.811	1.578
Other cardiovascular and circulatory diseases	a	I46-I47, I49-I52, I77-I79	5 year lag	F							4.11	3.74	3.405	3.102	2.826	2.576	2.35	2.144	1.957	1.787	1.56
Ischaemic stroke	a	I63, I64, I65, I66, I69.3, I69.4	5 year lag	M							4.175	3.805	3.468	3.161	2.882	2.627	2.395	2.184	1.992	1.816	1.582
Ischaemic stroke	a	I63, I64, I65, I66, I69.3, I69.4	5 year lag	F							6.02	5.357	4.767	4.243	3.777	3.363	2.994	2.666	2.375	2.115	1.778

Condition	Source	ICD -10 codes	Exposure	Sex	Relative risk by age															
					0 years	1-5 years	5-14 years	15-19 years	20-24 years	25-29 years	30-34 years	35-39 years	40-44 years	45-49 years	50-54 years	55-59 years	60-64 years	65-69 years	70-74 years	75-79 years	80+ years
Haemorrhagic stroke	a	I60, I61, I62, I69.0, I69.1, I69.2	5 year lag	M							4.175	3.805	3.468	3.161	2.882	2.627	2.395	2.184	1.992	1.816	1.582
Haemorrhagic stroke	a	I60, I61, I62, I69.0, I69.1, I69.2	5 year lag	F							6.02	5.357	4.767	4.243	3.777	3.363	2.994	2.666	2.375	2.115	1.778
Atherosclerosis	a	I70	5 year lag	M							4.153	3.785	3.451	3.146	2.868	2.616	2.386	2.176	1.985	1.811	1.578
Atherosclerosis	a	I70	5 year lag	F							4.11	3.74	3.405	3.102	2.826	2.576	2.35	2.144	1.957	1.787	1.56
Aortic aneurysm	a	I71	5 year lag	M							4.153	3.785	3.451	3.146	2.868	2.616	2.386	2.176	1.985	1.811	1.578
Aortic aneurysm	a	I71	5 year lag	F							4.11	3.74	3.405	3.102	2.826	2.576	2.35	2.144	1.957	1.787	1.56
Peripheral vascular disease	a	I72-I74	5 year lag	M							4.153	3.785	3.451	3.146	2.868	2.616	2.386	2.176	1.985	1.811	1.578
Peripheral vascular disease	a	I72-I74	5 year lag	F							4.11	3.74	3.405	3.102	2.826	2.576	2.35	2.144	1.957	1.787	1.56
Influenza and pneumonia	b	J10-11, J12-J18	Current	M				1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
Influenza and pneumonia	b	J10-11, J12-J18	Current	F				2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17
Chronic obstructive pulmonary disease	a	J43-J44	SIR	M							11.546	11.546	11.546	11.546	11.546	11.546	11.546	11.546	11.546	11.546	11.546
Chronic obstructive pulmonary disease	a	J43-J44	SIR	F							15.25	15.25	15.25	15.25	15.25	15.25	15.25	15.25	15.25	15.25	15.25
Asthma adolescents	b, e	J45-J46	Current 300+ cigarettes per annum	both			3.9	3.9													
Asthma (adult)	a	J45-J46	Current	M					2.098	2.098	2.098	2.098	2.098	2.098	2.098	2.098	2.098	2.098	2.098	2.098	2.098
Asthma (adult)	a	J45-J46	Current	F					1.976	1.976	1.976	1.976	1.976	1.976	1.976	1.976	1.976	1.976	1.976	1.976	1.976
Interstitial lung disease and pulmonary sarcoidosis	a	J84	SIR	M							2.086	2.086	2.086	2.086	2.086	2.086	2.086	2.086	2.086	2.086	2.086
Interstitial lung disease and pulmonary sarcoidosis	a	J84	SIR	F							1.967	1.967	1.967	1.967	1.967	1.967	1.967	1.967	1.967	1.967	1.967
Other chronic respiratory diseases	a	J47, J70, J80-J82, J85-J86, J90-J91, J93-J94, J96, J98	SIR	M							2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1

Condition	Source	ICD -10 codes	Exposure	Sex	Relative risk by age															
					0 years	1-5 years	5-14 years	15-19 years	20-24 years	25-29 years	30-34 years	35-39 years	40-44 years	45-49 years	50-54 years	55-59 years	60-64 years	65-69 years	70-74 years	75-79 years	80+ years
Other chronic respiratory diseases	a	J47, J70, J80-J82, J85-J86, J90-J91, J93-J94, J96, J98	SIR	F							1.982	1.982	1.982	1.982	1.982	1.982	1.982	1.982	1.982	1.982	1.982
Peptic ulcer disease	a	K25-28	5 year lag	Both							2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04
Rheumatoid arthritis	a	M05-M06	5 year lag	Both							1.375	1.375	1.375	1.375	1.375	1.375	1.375	1.375	1.375	1.375	1.375
Erectile dysfunction	b, f	N52.03	Current smoker	M							OR = 1.51	OR = 1.51	OR = 1.51	OR = 1.51	OR = 1.51	OR = 1.51	OR = 1.51	OR = 1.51	OR = 1.51	OR = 1.51	OR = 1.51
Reduced fertility in women	b	N97	Current smoker	F																	
Ectopic pregnancy	b, g	O00	Current smoker	F				OR = 1.43	OR = 1.43	OR = 1.43	OR = 1.43	OR = 1.43	OR = 1.43	OR = 1.43							
Hypertension in pregnancy (protective)	b	O10-O16	Smoking whilst pregnant	F				0.67	0.67	0.67	0.67	0.67	0.67	0.67							
Premature rupture of membranes	b, h	O42	Smoking whilst pregnant	F				1.81	1.81	1.81	1.81	1.81	1.81	1.81							
Placenta previa and other antepartum haemorrhage	b, h	O44, O46	Smoking whilst pregnant	F				1.58	1.58	1.58	1.58	1.58	1.58	1.58							
Placental abruption	b, h	O45	Smoking whilst pregnant					1.62	1.62	1.62	1.62	1.62	1.62								
Stillbirth	b, g	Z37.1, Z37.3, Z37.4, Z37.6, Z37.7	Smoking whilst pregnant	F				1.46	1.46	1.46	1.46	1.46	1.46	1.46							
Miscarriage	i	O03	Smoking whilst pregnant					1.23	1.23	1.23	1.23	1.23	1.23	1.23							
Hip Fracture	a	S72	5 year lag	Both							1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85
Non-Hip Fracture	a	S02, S12, S22, S32, S42, S52, S82, S92	5 year lag	Both							1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Fire injuries	b	X00-X01, X04-X09	Current	Both	AF = 0.136	AF = 0.136	AF = 0.136	AF = 0.136	AF = 0.136	AF = 0.136	AF = 0.136	AF = 0.136	AF = 0.136	AF = 0.136	AF = 0.136	AF = 0.136	AF = 0.136	AF = 0.136	AF = 0.136	AF = 0.136	AF = 0.136
Exposure to secondhand smoke																					
Lung cancer	b	C34	Adults second-hand smoke	M							1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37

Condition	Source	ICD -10 codes	Exposure	Sex	Relative risk by age																
					0 years	1-5 years	5-14 years	15-19 years	20-24 years	25-29 years	30-34 years	35-39 years	40-44 years	45-49 years	50-54 years	55-59 years	60-64 years	65-69 years	70-74 years	75-79 years	80+ years
Lung cancer	b	C34	Adults second-hand smoke	F							1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22
Otitis media	b	H65-H67	Children secondhand smoke		OR = 1.80	OR = 1.80	OR = 1.80														
Ischaemic heart disease	b	I20-I25	Adults second-hand smoke								1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16
Cerebrovascular disease	b	I60-I69	Adults second-hand smoke	Both							1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Lower respiratory illness (child)	b	J12-18, J20-J22	Children secondhand smoke	Both	OR = 1.46	OR = 1.46	OR = 1.46														
Asthma (child)	b	J45-J46	Children secondhand smoke - one parent	Both	OR = 1.18	OR = 1.18	OR = 1.18														
Asthma (child)	b	J45-J46	Children secondhand smoke - both parents	Both	OR = 1.47	OR = 1.47	OR = 1.47														
Low birthweight	b	P05, P07	Children secondhand smoke	Both	OR = 2.0																
Orofacial clefts	b	Q35-Q37	In-utero secondhand smoke	Both	OR = 1.28	OR = 1.28															
SIDS	j	R95	Children secondhand smoke	Both	OR = 4.67																

Key:
a Global Burden of Disease Study (Gakidou et al., 2017; GBD 2015 Tobacco Collaborators, 2017a).
b US Surgeon General (US Department of Health and Human Services, 2014).
c IARC (International Agency for Research on Cancer, 2012).
d Assessment of strength of causal relationship from US Surgeon General (US Department of Health and Human Services, 2004), relative risk from Zhou et al. (2008).
e Assessment of strength of causal relationship from US Surgeon General (US Department of Health Human Services, 2012), relative risk from Gilliland et al.(2006) 2006.
f Assessment of strength of causal relationship from US Surgeon General (US Department of Health Human Services, 2012), odds ratio from Cao et al. (2013).

g Assessment of strength of causal relationship from US Surgeon General (US Department of Health Human Services, 2012), odds ratio from Hyland et al. (2015).
h Assessment of strength of causal relationship from US Surgeon General (US Department of Health Human Services, 2001), relative risk from Castles et al. (1999).
i Assessed by US Surgeon General as “The evidence is suggestive but not sufficient to infer a causal relationship” (US Department of Health and Human Services, 2014). but we regard subsequent studies as having strengthened the evidence for inclusion sufficiently to warrant inclusion in this study. Relative risk estimate from Pineles et al. (2014).
j Assessment of strength of causal relationship from US Surgeon General (US Department of Health Human Services, 2001), relative risk from Mitchell and Milerad (1999).

3.2 Aetiological or attributable fractions

Once relative risks from exposure to a hazard have been identified, it is then necessary to identify the proportion of mortality and morbidity from these partially caused conditions attributable to smoking in the population and timeframe of interest. The preferred approach is to assess the causal relationship on a condition by condition basis, using what are called aetiological or attributable fractions (i.e. the proportion of deaths or cases of the condition caused by smoking or exposure to secondhand smoke). Attributable fractions can be derived using direct or indirect methods.

The indirect method, which is considered to be more robust, requires two sets of information. These are: the relative risk, derived from analysis of case control or cohort studies, of developing the condition of interest (or dying from a particular cause) for those who smoke tobacco or who are exposed to secondhand smoke at home, in-utero, or (formerly) in the workplace; and, the proportion of the population by age category and gender who are exposed to tobacco smoke, based upon self-report surveys of consumption and consumption behaviours.

Due to the broad research interest in identifying the harms arising from tobacco use, together with generally accurate survey response data, as tobacco use is legal, most conditions caused by tobacco have well established relative risks allowing AFs to be calculated using the indirect approach.

The method for calculating attributable fractions from relative risks was described by English et al. in 1995, and is still used today (English et al., 1995). The formula used to calculate the attributable fraction (AF) for a condition with respect to a particular population where the risk varies by consumption is (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 -
i represents the consumption categories used (in most cases for this study this will be either the SIR or daily smokers five years ago);
P_i is the proportion of the population of interest who are in the particular consumption category i; and RR_i is the relative risk of a person in consumption category i acquiring the condition.

If the epidemiological data available are expressed in terms of odds ratios, these need to be converted to a relative risk to allow the calculation of attributable fractions. This can be done using the following formula (Grant, 2014):

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

Where:
RR = relative risk for the risk factor in question;
OR = odds ratio for the risk factor in question;
p_0 = the baseline risk

The alternative approach to the indirect method, the direct method of calculating attributable fractions is based on a study(ies) making a direct attribution on a case by case basis of the contribution of the substance use to the condition or injury (e.g., a study could analyse incident report data to identify the

proportion of house fire injuries where the cause of ignition was a cigarette or discarded match). Direct attribution has important limitations, such as variability in the criteria used to determine attribution, observer variation, and a failure to reflect the exposure patterns of the population to which it is being applied. It also reflects the consumption patterns at the time and place of the original study (although established methods exist to adjust AFs estimated by direct methods for differences in consumption behaviour – see below). Direct methods are generally only used when there are no estimates of the relative risk of the condition of interest.

In general, estimates of harm attributable to substance use will not adjust the attributable fractions calculated by direct methods for local and current consumption patterns. However, WHO sets out an approach which can be used where either local consumption patterns differ notably from those in the reference population from which the directly derived attributable fraction was calculated, or where a study is attempting to assess the impact of a change in consumption patterns (World Health Organization, 2000). In these cases the use of attributable fractions estimated by direct methods has the potential to under- or over-state the level of tobacco attributable harm. This is the case for fire injuries as the AF derives from English et al. (1995), when Australian smoking prevalence rates were very different. We propose to adjust the AF for fire injuries to reflect changes in consumption patterns. In addition, the introduction of reduced-ignition propensity cigarettes in 2010 means that the number of fires (and injuries) will have reduced (Bonander et al., 2015; Saar, 2018).

The formula used to adjust AFs estimated using direct methods is:

$$AF_x = \frac{((F * AF_{ref}) + AF_{ref})}{(((F * AF_{ref}) + AF_{ref}) + (1 - AF_{ref}))}$$

Where -

AF_x = the new attributable fraction for year x (the study year)

AF_{ref} = is the attributable fraction calculated using the direct method in some previous year, and

F = the change in exposure to the risk factor, expressed as:

$$F = \frac{(P_{ref} - P_x)}{(P_{ref} * -1)}$$

Where -

P_{ref} = the prevalence in the reference year of the original study, and

P_x = prevalence in the new target year x.

For the current study, the relative risk estimates set out in Table 3.1 were combined with relevant prevalence estimates for the condition of those who identify as Aboriginal or Torres Strait Islanders and those who do not identify as Aboriginal or Torres Strait Islanders, with each split by self-reported gender. Therefore, four sets of attributable fractions have been calculated.

CHAPTER 4: PREMATURE MORTALITY

Steve Whetton, Suraya Abdul Halim & Robert J. Tait

4.1 Smoking-attributable mortality

The population-specific attributable fractions were applied to AIHW data on the number of deaths by condition. Deaths data were extracted for two financial years (2014/15 and 2015/16) to reduce the extent of random year-to-year fluctuations in deaths by condition, with the results presented based on the average of the time period included.

Deaths data were provided separately for those identified in the dataset as Aboriginal and Torres Strait Islanders and the remainder of the Australian population. Due to data limitations, Aboriginal and Torres Strait Islander identification was not possible for deaths that occurred in Victoria, Tasmania and the Australian Capital Territory and for this reason, the Aboriginal and Torres Strait Islander estimates relate only to deaths that occurred in the remaining five States and Territories. In addition, there were 951 deaths for which Aboriginal and Torres Strait identification could not be determined and these deaths have been excluded from the dataset by the AIHW.

In order to increase the confidentiality of the data, they were aggregated to broader age categories than in the relative risk estimates. To ensure confidentiality, AIHW policy is that where a cell (e.g. cause, sex, age-group combination) has between one to four deaths in the time period being considered, the specific number of deaths will not be published for that cell nor will it be included in the total, with the data instead reported as <5. Total premature mortality is consequently slightly underestimated, as there are a number of cells in which the specific number of deaths is confidentialised. Over the two-year period, there were 172 cells where the deaths were reported as less than five, and if we take an average of two deaths per category over the two years, 344 deaths potentially have been excluded from our analysis or 172 from the one-year cost calculation. Also, there were 951 deaths excluded from the AIHW data provided as the Aboriginal and Torres Strait Islander identification could not be determined: some (unknown) proportion of these is likely to be smoking-related deaths.

Table 4.1 summarises the overall impact of smoking on premature mortality. Table 4.2 reports the estimated number of smoking attributable deaths for the population who are not identified as Aboriginal and Torres Strait Islanders, and Table 4.3 reports smoking attributable deaths for those identified as Aboriginal and Torres Strait Islanders.

Table 4.1: Deaths caused and averted by smoking, 2015/16

.	0-14 years	15-24 years	25-44 years	45-64 years	65+ years	All ages
Deaths averted, females, other Australians	0.0	0.0	0.0	-0.5	-33.9	-34.4
Deaths caused, females, other Australians	3.5	0.0	92.2	988.8	6,924.0	8,008.5
Net deaths, females, other Australians	***3.5***	***0.0***	***92.2***	***988.3***	***6,890.1***	***7,974.0***
Deaths averted, males, other Australians	0.0	0.0	0.0	-2.0	-43.2	-45.2
Deaths caused, males, other Australians	4.4	0.9	118.7	2,084.4	9,008.4	11,216.8
Net deaths, males, other Australians	***4.4***	***0.9***	***118.7***	***2,082.4***	***8,965.2***	***11,171.7***
Deaths averted, female, Aboriginals and Torres Strait Islanders	0.0	0.0	0.0	0.0	-1.4	-1.4
Deaths caused, female, Aboriginals and Torres Strait Islanders	0.6	0.0	31.4	177.8	186.9	396.7
Net deaths, female, Aboriginals and Torres Strait Islanders	***0.6***	***0.0***	***31.4***	***177.8***	***185.5***	***395.2***
Deaths averted, males, Aboriginals and Torres Strait Islanders	0.0	0.0	0.0	0.0	-0.6	-0.6
Deaths caused, males, Aboriginals and Torres Strait Islanders	1.4	0.0	50.3	263.5	176.5	491.7
Net deaths, males, Aboriginals and Torres Strait Islanders	***1.4***	***0.0***	***50.3***	***263.5***	***176.0***	***491.1***
TOTAL NET DEATHS	**9.9**	**0.9**	**292.5**	**3,512.0**	**16,216.7**	**20,032.1**

Total net premature deaths amongst those not identified as Aboriginal and Torres Strait Islanders are estimated to be at least 19,145 (noting that there are a number of conditions for which the number of deaths could not be provided by the AIHW). A majority of the deaths were amongst males with 11,171 [6] premature deaths compared to 7,974 premature deaths amongst females. Gross premature deaths attributable to smoking are slightly higher as there are two conditions for which smoking has a protective effect – endometrial cancer in women aged 65 years and over, and Parkinson's disease, preventing an estimated 79 premature deaths from these conditions in our dataset [7]. Thus, the harms from the caused conditions substantially outweigh the benefits from the prevented conditions.

Tracheal, bronchus and lung cancer is the most significant cause of smoking attributable deaths in the population not identified as Aboriginal and Torres Strait Islanders, accounting for 3,984 male deaths and 2,351 female deaths. Chronic obstructive pulmonary disease causes almost as many smoking attributable deaths, accounting for 2,422 male deaths and 2,297 female deaths. Ischaemic heart disease is the only other individual condition that accounts for more than 1,000 deaths, with smoking attributable cases responsible for 1,532 premature deaths amongst males and 1,026 amongst females.

A clear majority of the deaths occur amongst those aged 65 years old and over, with 15,855 of the premature deaths, or 83 per cent, in this age-group. Almost all of the other deaths occurred in those aged 45-64.

[6] In the text, deaths are reported as whole numbers, but cost calculations include 'fractions' of deaths e.g. total deaths = 20,032.1

[7] While hypertension in pregnancy also has a protective effect, there were no cases of premature mortality due to hypertension in pregnancy in the dataset.

Table 4.2: Annual smoking attributable deaths – not identified as Aboriginal and Torres Strait Islanders, average 2014/15 and 2015/16

Cause	Sex	0-14 years	15-24 years	25-44 years	45-64 years	65+ years	All ages
Tuberculosis	M			*	0.4	1.1	1.5
Tuberculosis	F			0.0	0.0	0.5	0.5
Lip oral cancer	M				68.5	176.2	244.7
Lip oral cancer	F			2.6	15.6	80.2	98.5
Nasopharynx cancer	M				25.5	55.2	80.7
Nasopharynx cancer	F			*	5.0	14.0	19.1
Oesophageal cancer	M				106.0	333.7	439.7
Oesophageal cancer	F			1.7	19.8	154.8	176.3
Stomach cancer	M				14.6	71.1	85.7
Stomach cancer	F			1.6	4.8	30.5	36.9
Colon rectum cancer	M				18.4	92.4	110.8
Colon rectum cancer	F			3.4	14.5	117.2	135.0
Liver cancer	M				27.1	71.5	98.6
Liver cancer	F			0.8	7.7	51.2	59.6
Pancreatic cancer	M				50.0	219.3	269.3
Pancreatic cancer	F			1.7	21.8	189.9	213.4
Nasal cavity cancer	M				0.7	1.5	2.3
Nasal cavity cancer	F			0.0	*	*	0.0
Accessory sinuses cancer	M				2.3	4.1	6.4
Accessory sinuses cancer	F			*	*	1.7	1.7
Larynx cancer	M				31.3	102.3	133.6
Larynx cancer	F			0.0	2.9	13.8	16.7
Tracheal bronchus lung cancer	M				780.1	3,204.0	3,984.1
Tracheal bronchus lung cancer	F			25.0	453.1	1,873.4	2,351.4
Cervical cancer	F			3.6	6.0	12.6	22.2
Endometrial cancer	F			0.0	0.0	-15.3	-15.3
Kidney cancer	M				21.2	80.7	101.9
Kidney cancer	F			0.3	3.1	25.5	28.9
Bladder cancer	M				15.5	205.4	220.8
Bladder cancer	F			*	3.3	75.6	79.0
Acute myeloid leukaemia	M				9.3	73.2	82.5
Acute myeloid leukaemia	F			0.4	1.3	11.3	13.0
Diabetes mellitus type 2	M			0.3	8.2	35.4	43.8
Diabetes mellitus type 2	F			0.1	0.8	5.8	6.7
Parkinson's disease	M			0.0	-2.0	-43.2	-45.2
Parkinson's disease	F			0.0	-0.5	-18.6	-19.1
Cataract				0.0	0.0	0.0	0.0
Cataract				0.0	0.0	0.0	0.0
Macular degeneration	M			0.0	0.0	*	0.0
Macular degeneration	F			0.0	0.0	0.0	0.0
Hypertensive heart disease	M			2.3	20.1	31.8	54.3
Hypertensive heart disease	F			*	6.1	42.7	48.8
Ischaemic heart disease	M			72.7	501.7	958.3	1,532.7
Ischaemic heart disease	F			19.0	130.6	876.7	1,026.3
Atrial fibrillation and flutter	M			*	5.0	68.7	73.7
Atrial fibrillation and flutter	F			0.0	2.4	89.3	91.6
Other cardiovascular circulatory diseases	M			12.0	31.2	145.5	188.7
Other cardiovascular circulatory diseases	F			5.9	15.2	148.3	169.4
Ischaemic stroke	M			3.9	35.1	254.1	293.1

Cause	Sex	0-14 years	15-24 years	25-44 years	45-64 years	65+ years	All ages
Ischaemic stroke	F			2.3	22.7	407.6	432.7
Haemorrhagic stroke	M			10.5	59.8	98.8	169.2
Haemorrhagic stroke	F			13.2	64.3	114.0	191.5
Atherosclerosis	M			*	1.1	4.7	5.8
Atherosclerosis	F			0.0	*	5.8	5.8
Aortic aneurysm	M			5.8	19.1	48.4	73.4
Aortic aneurysm	F			1.6	7.0	27.7	36.3
Peripheral vascular disease	M			1.0	6.2	29.6	36.7
Peripheral vascular disease	F			*	2.1	23.0	25.2
Influenza and pneumonia	M		0.3	3.1	10.8	60.7	74.9
Influenza and pneumonia	F		0.0	1.9	8.3	94.1	104.4
Chronic obstructive pulmonary disease	M				170.6	2,251.7	2,422.3
Chronic obstructive pulmonary disease	F			3.6	150.2	2,142.8	2,296.6
Asthma (adolescent)	M		0.1				0.1
Asthma (adolescent)	F		*				0.0
Asthma	M		0.4	4.0	4.9	6.9	16.1
Asthma	F		*	1.4	4.8	12.2	18.4
Interstitial lung disease	M			*	6.5	116.1	122.6
Interstitial lung disease	F			0.4	3.2	79.9	83.5
Other chronic respiratory diseases	M			0.0	4.9	60.5	65.3
Other chronic respiratory diseases	F			0.5	2.9	92.9	96.3
Peptic ulcer disease	M			0.9	3.2	9.1	13.2
Peptic ulcer disease	F			0.4	1.6	6.8	8.7
Rheumatoid arthritis	M			0.0	0.5	1.4	1.9
Rheumatoid arthritis	F			0.0	0.4	3.2	3.6
Ectopic pregnancy	F			*	0.0	0.0	0.0
Hypertension in pregnancy	F			*	0.0	0.0	0.0
Premature rupture of membranes	F			0.0	0.0	0.0	0.0
Placenta previa and other antepartum haemorrhage	F			0.0	0.0	0.0	0.0
Placental abruption	F			0.0	0.0	0.0	0.0
Hip fracture	M			*	0.6	13.0	13.6
Hip fracture	F			0.0	*	14.9	14.9
Non-hip fracture	M			0.2	0.8	3.1	4.1
Non-hip fracture	F			*	0.2	3.0	3.1
Both hip and non-hip fractures	M			0.0	0.0	0.3	0.3
Both hip and non-hip fractures	F			0.0	*	0.6	0.6
Fire injuries	M	*	*	0.4	1.0	1.5	2.8
Fire injuries	F	*	0.0	0.3	0.4	1.4	2.1
Lung cancer (secondhand smoke)	M			0.5	11.8	43.1	55.4
Lung cancer (secondhand smoke)	F			0.2	3.9	12.6	16.7
Otitis media (secondhand smoke)	M	0.0	0.0				0.0
Otitis media (secondhand smoke)	F	0.0	0.0				0.0
Ischaemic heart disease (secondhand smoke)	M			0.8	8.0	43.7	52.6
Ischaemic heart disease (secondhand smoke)	F			0.1	1.3	31.1	32.6
Cerebrovascular disease (secondhand smoke)	M			0.3	2.6	30.3	33.1
Cerebrovascular disease (secondhand smoke)	F			0.2	1.5	35.2	36.9
Lower respiratory illness (secondhand smoke)	M	0.2					0.2

Cause	Sex	0-14 years	15-24 years	25-44 years	45-64 years	65+ years	All ages
Lower respiratory illness (secondhand smoke)	F	0.2					0.2
Asthma (secondhand smoke)	M	0.0					0.0
Asthma (secondhand smoke)	F	0.0					0.0
Low birthweight (secondhand smoke)	M	1.6					1.6
Low birthweight (secondhand smoke)	F	1.2					1.2
Orofacial clefts (secondhand smoke)	M	*					0.0
Orofacial clefts (secondhand smoke)	F	0.0					0.0
Sudden infant death syndrome (secondhand smoke)	M	2.6					2.6
Sudden infant death syndrome (secondhand smoke)	F	2.1					2.1
Total male deaths		***4.4***	***0.9***	***118.7***	***2,082.4***	***8,965.2***	***11,171.7***
Total female deaths		***3.5***	***0.0***	***92.2***	***988.3***	***6,890.1***	***7,974.0***
Total deaths		***8.0***	***0.9***	***210.8***	***3,070.8***	***15,855.3***	***19,145.7***

Note: * Indicates a condition/age-group/Aboriginal and Torres Strait Islander status/year combination where the number of deaths in the AIHW deaths file was between 1 and 4 and the actual number of deaths was confidentialised in the data file. Smoking attributable deaths could not be calculated in these cases and they are not included in the total.

Table 4.3: Annual smoking attributable deaths – identified as Aboriginal and Torres Strait Islanders, average 2014/15 and 2015/16 (excluding Victoria, Tasmania and the Australian Capital Territory)

Cause	Sex	0-14 years	15-24 years	25-44 years	45-64 years	65+ years	All ages
Tuberculosis	M			0.0	*	0.0	0.0
Tuberculosis	F			0.0	*	*	0.0
Lip oral cancer	M			*	12.3	4.4	16.7
Lip oral cancer	F			*	4.8	3.1	7.9
Nasopharynx cancer	M			*	5.6	3.3	8.9
Nasopharynx cancer	F			*	1.8	0.0	1.8
Oesophageal cancer	M			*	11.5	3.4	14.9
Oesophageal cancer	F			0.0	3.4	3.9	7.3
Stomach cancer	M			*	2.1	1.5	3.6
Stomach cancer	F			*	0.6	1.8	2.4
Colon rectum cancer	M			*	1.5	1.3	2.8
Colon rectum cancer	F			*	1.3	2.7	4.0
Liver cancer	M			0.8	3.4	2.7	6.9
Liver cancer	F			0.0	3.4	3.0	6.3
Pancreatic cancer	M			1.2	4.6	4.5	10.3
Pancreatic cancer	F			*	4.3	3.8	8.1
Nasal cavity cancer	M			0.0	0.0	0.0	0.0
Nasal cavity cancer	F			0.0	0.0	0.0	0.0
Accessory sinuses cancer	M			*	0.0	0.0	0.0
Accessory sinuses cancer	F			0.0	0.0	0.0	0.0
Larynx cancer	M			0.0	4.7	3.3	8.0
Larynx cancer	F			0.0	2.2	*	2.2
Tracheal bronchus lung cancer	M			5.6	54.3	50.2	110.1
Tracheal bronchus lung cancer	F			2.7	48.7	46.2	97.6
Cervical cancer	F			1.8	2.2	1.7	5.7
Endometrial cancer	F			0.0	0.0	-1.0	-1.0
Kidney cancer	M			*	1.4	1.1	2.5
Kidney cancer	F			0.0	*	1.2	1.2

Cause	Sex	0-14 years	15-24 years	25-44 years	45-64 years	65+ years	All ages
Bladder cancer	M			0.0	1.7	3.7	5.4
Bladder cancer	F			0.0	*	*	0.0
Acute myeloid leukaemia	M			*	0.7	1.0	1.7
Acute myeloid leukaemia	F			*	0.3	0.5	0.9
Diabetes mellitus type 2	M			0.7	5.7	1.8	8.1
Diabetes mellitus type 2	F			0.1	1.2	1.1	2.5
Parkinson's disease	M			0.0	0.0	-0.6	-0.6
Parkinson's disease	F			0.0	0.0	-0.4	-0.4
Cataract				0.0	0.0	0.0	0.0
Cataract				0.0	0.0	0.0	0.0
Macular degeneration	M			0.0	0.0	0.0	0.0
Macular degeneration	F			0.0	0.0	0.0	0.0
Hypertensive heart disease	M			*	2.6	0.7	3.3
Hypertensive heart disease	F			*	*	1.4	1.4
Ischaemic heart disease	M			33.1	93.9	16.4	143.4
Ischaemic heart disease	F			14.7	42.8	23.6	81.2
Atrial fibrillation and flutter	M			0.0	*	*	0.0
Atrial fibrillation and flutter	F			*	1.0	2.4	3.4
Other cardiovascular circulatory diseases	M			1.6	6.2	2.0	9.7
Other cardiovascular circulatory diseases	F			1.6	2.8	4.3	8.7
Ischaemic stroke	M			*	5.0	3.8	8.8
Ischaemic stroke	F			*	4.1	9.2	13.3
Haemorrhagic stroke	M			3.0	5.0	0.8	8.8
Haemorrhagic stroke	F			2.9	8.2	4.0	15.2
Atherosclerosis	M			0.0	0.0	*	0.0
Atherosclerosis	F			0.0	0.0	0.0	0.0
Aortic aneurysm	M			*	1.2	0.5	1.7
Aortic aneurysm	F			*	*	*	0.0
Peripheral vascular disease	M			0.0	*	0.4	0.4
Peripheral vascular disease	F			*	*	*	0.0
Influenza and pneumonia	M			0.9	3.6	2.3	6.8
Influenza and pneumonia	F			1.6	3.6	2.9	8.0
Chronic obstructive pulmonary disease	M			*	30.0	62.1	92.2
Chronic obstructive pulmonary disease	F			2.7	34.6	61.1	98.4
Asthma (adolescent)	M	*		0.0	0.0	0.0	0.0
Asthma (adolescent)	F	0.0		0.0	0.0	0.0	0.0
Asthma	M	*	0.0	*	0.0	*	0.0
Asthma	F	0.0	*	0.9	1.0	1.3	3.2
Interstitial lung disease	M			*	*	0.7	0.7
Interstitial lung disease	F			*	1.2	1.6	2.8
Other chronic respiratory diseases	M			2.3	2.0	1.2	5.4
Other chronic respiratory diseases	F			1.9	2.3	3.8	8.0
Peptic ulcer disease	M			0.0	0.0	0.0	0.0
Peptic ulcer disease	F			0.0	0.0	0.0	0.0
Rheumatoid arthritis	M			0.0	0.0	0.0	0.0
Rheumatoid arthritis	F			0.0	0.0	0.0	0.0
Ectopic pregnancy	F		0.0	0.0	0.0	0.0	0.0
Hypertension in pregnancy	F		0.0	0.0	0.0	0.0	0.0
Premature rupture of membranes	F		0.0	0.0	0.0	0.0	0.0
Placenta previa and other antepartum haemorrhage	F		0.0	0.0	0.0	0.0	0.0
Placental abruption	F		0.0	0.0	0.0	0.0	0.0

Cause	Sex	0-14 years	15-24 years	25-44 years	45-64 years	65+ years	All ages
Hip fracture	M			0.0	0.0	*	0.0
Hip fracture	F			0.0	*	*	0.0
Non-hip fracture	M			0.0	0.0	0.0	0.0
Non-hip fracture	F			*	0.0	*	0.0
Both hip and non-hip fractures	M			0.0	0.0	0.0	0.0
Both hip and non-hip fractures	F			0.0	0.0	0.0	0.0
Fire injuries	M	*		*	*	0.0	0.0
Fire injuries	F	*		*	*	*	*
Lung cancer (secondhand smoke)	M			0.2	1.7	1.6	3.5
Lung cancer (secondhand smoke)	F			0.0	0.7	0.7	1.5
Otitis media (secondhand smoke)	M			0.0	0.0	0.0	0.0
Otitis media (secondhand smoke)	F			0.0	0.0	0.0	0.0
Ischaemic heart disease (secondhand smoke)	M			0.7	2.4	1.3	4.5
Ischaemic heart disease (secondhand smoke)	F			0.2	0.8	0.9	1.9
Cerebrovascular disease (secondhand smoke)	M			0.1	0.4	0.6	1.2
Cerebrovascular disease (secondhand smoke)	F			0.1	0.4	0.8	1.3
Lower respiratory illness (secondhand smoke)	M	0.0					0.0
Lower respiratory illness (secondhand smoke)	F	0.0					0.0
Asthma (secondhand smoke)	M	*					0.0
Asthma (secondhand smoke)	F	0.0					0.0
Low birthweight (secondhand smoke)	M	0.3					0.3
Low birthweight (secondhand smoke)	F	0.3					0.3
Orofacial clefts (secondhand smoke)	M	*					0.0
Orofacial clefts (secondhand smoke)	F	*					0.0
Sudden infant death syndrome (secondhand smoke)	M	1.0					1.0
Sudden infant death syndrome (secondhand smoke)	F	0.3					0.3
Total male deaths		***1.4***	***0.0***	***50.3***	***263.5***	***176.0***	***491.1***
Total female deaths		***0.6***	***0.0***	***31.4***	***177.8***	***185.5***	***395.2***
Total deaths		***2.0***	***0.0***	***81.7***	***441.3***	***361.4***	***886.4***

Note: * Indicates a condition/age-group/Aboriginal and Torres Strait Islander status/year combination where the number of deaths in the AIHW deaths file was between 1 and 4 and the actual number of deaths was confidentialised in the data file. Smoking attributable deaths could not be calculated in these cases and they are not included in the total.

Total net premature deaths amongst those who could be identified in the deaths data as Aboriginal and Torres Strait Islanders are estimated to be at least 886 (noting that there are a number of conditions for which the total number of deaths could not be provided by the AIHW due to confidentiality requirements) (see Table 4.3). A majority of the deaths were amongst males, with 491 premature deaths compared to 395 premature deaths amongst females, although the distribution of deaths by gender was less skewed towards males amongst those identified as Aboriginal and Torres Strait Islanders than it was for the remainder of the population. Gross premature deaths attributable to smoking are slightly higher due to the protective effects with two conditions (endometrial cancer in older women and Parkinson's disease) which were estimated to prevent two premature deaths in our dataset.

The relative impact of conditions was slightly different for those who could be identified as Aboriginal and Torres Strait Islander, with ischaemic heart disease being the most common cause of total smoking

attributable deaths. Ischaemic heart disease was responsible for 143 male deaths and 81 female deaths. Tracheal, bronchus and lung cancer was the second most significant cause of smoking attributable deaths amongst those identified as Aboriginal and Torres Strait Islanders, accounting for 110 male deaths and 97 female deaths. Chronic obstructive pulmonary disease caused almost as many smoking attributable deaths, and was the most significant cause of deaths amongst females, accounting for 98 female deaths, and 92 male deaths.

Unlike the remainder of the population, the age range with the largest proportion of smoking attributable deaths, amongst those who could be identified as Aboriginal and Torres Strait Islanders, was those aged 45 to 64, with 441 net deaths occurring in this age-group (49.8 % of the total). Almost all of the remaining deaths occurred amongst those aged 65 years old and over (361 deaths, 40.8 % of the total).

4.2 Tangible costs of premature mortality

Two broad forms of social cost (as opposed to private cost) arise as a result of premature mortality: tangible and intangible costs. Tangible costs include: the present value of lost expected lifetime labour in paid employment not captured by the substance user; 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 government. There are also intangible costs of premature mortality. 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 years of life lost estimate, whereas intangible costs are calculated directly from the number of deaths that occurred in the reference year.

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

Estimates related to lifetime costs or savings are calculated as present values of future benefits or costs assessed over a 30-year horizon using a real discount rate of seven per cent as recommended in Australian Government guidance (Department of Finance and Administration, 2006; Department of the Prime Minister and Cabinet, 2016).

The 'years of life lost' (YLLs) for each premature death were calculated using age and gender specific estimates for years of life remaining from the Australian Bureau of Statistics' life tables (Australian Bureau of Statistics, 2015a), although benefits or costs occurring more than 30 years beyond 2015/16 were not included in the analysis based on the Australian Government recommendations noted above. This will somewhat understate costs, as the expected years of life remaining for those who die prematurely is greater than thirty years for around seven per cent of smoking attributable deaths. Years of life lost were not discounted, with discounting of future values introduced through discounting the costs and offsetting savings arising from the YLLs.

4.2.1 Potential years of life lost

Many of the tangible costs of premature mortality are age- and gender-specific. In order to support these calculations, we have calculated the potential years of life lost (PYLL) for each of the mortality age-group categories by gender and Aboriginal and Torres Strait Islander identification using the expected years of life remaining in the Australian Bureau of Statistics' life tables (Australian Bureau of Statistics, 2013, 2018g).

As the age categories in the deaths data are very broad, these were disaggregated using data supplied by the AIHW on deaths by five-year age categories for potentially smoking attributable causes for the population not identified as Aboriginal and Torres Strait Islanders. These deaths were converted to smoking attributable deaths using the relevant attributable fractions, with the assumption made that all deaths in a broad age category would be distributed in the same proportions between five-year age categories as the total smoking attributable deaths.

Within the five-year age category it was assumed, for the purposes of the PYLL calculation that all deaths occurred in the mid-point year (i.e. age 27 for deaths amongst those aged 25 to 29) with two exceptions. For deaths amongst those aged 0 to 4 years old it was assumed that the deaths occurred at one year old, and for deaths in the age category 85+ years it was assumed deaths occurred at age 87. Among those identified as Aboriginal and Torres Strait Islanders, the same approach of allocating deaths from the broad age categories provided by the AIHW to five-year age categories was used with the PYLL.

4.2.2 Workplace costs

The workplace costs of a premature death are the present value of expected future economic output from the deceased individual (excluding the income that they would have received through wages which is a private cost), together with the cost to employers of filling a job vacancy.

The impact of a smaller labour force on GDP due to smoking attributable deaths in 2015/16 was calculated as a present value over a 30-year timeframe (to align with Commonwealth Department of Finance guidance) using a real discount rate of seven per cent. Cost of filling job vacancies all 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, 2017a, Data extraction by the authors). This was then applied to the potential years of life lost data by age-group and gender to identify the expected number of years of *employment* lost in each financial year.

For the age and gender profile of the smoking attributable deaths, the greatest impact on the labour force occurred in 2015/16 at 3,560.8 employee years. The impact on the labour force was estimated to fall in each subsequent year, reaching 24.0 employee years by 2045/46.

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 die prematurely from smoking attributable causes differs from the average. It has been assumed that the economic output of those in work would have equalled the population mean. 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, 2018b, f) and was $139,211 in 2015/16. We assumed that GDP per employee will grow at its long-run average real growth rate of 1.5 per cent thereafter.

The value of lost GDP in 2015/16 due to premature smoking attributable mortality which occurs in 2015/16 was $495.7 million. The total present value cost to GDP of premature smoking attributable mortality which occurred in 2015/16 assessed over 30 years was **$3.4 billion** in 2015/16 values.

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, 2018c) and applying the estimate of 3,560.8 fewer employees in 2015/16, gives a total cost of **$28.0 million**.

4.2.3 Reductions in labour in the household

Collins and Lapsley based their estimates of production losses in the household sector on the ABS publication Unpaid Work and the Australian Economy 1997 (Australian Bureau of Statistics, 1997; Collins and Lapsley, 2008). Despite being dated, this remains the best available source of data on unpaid work in the household. 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 would be 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 report details two broad approaches that can be taken to valuing unpaid household labour: individual function replacement cost; and, the opportunity cost of time. Within these broad approaches: unpaid household labour can be valued as the cost of hiring specialists to undertake each task, by the cost of hiring a housekeeper to undertake all unpaid labour in the household, or by a hybrid of the two; and, opportunity cost can be measured based on pre-tax or post-tax income. We prefer 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 is also the approach taken by Collins and Lapsley in their study (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 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, 2018c) 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 [8]. The estimated number of potential years of life lost in these age ranges was calculated from the PYLL data for each year of the 30-year analysis period.

Our central estimate is that there were 8,356 years of life lost to smoking in the relevant age ranges in 2015/16, falling to 175.6 by 2043/44. Assessing the present value of lost labour in the household over a 30-year timeframe gives an estimated cost of **$623.7 million**.

4.2.4 Avoided health care costs

Whilst smoking attributable diseases cause significant healthcare costs (see Chapters 5 and 6) the premature deaths of smokers' produces partially offsetting reductions in lifetime healthcare costs which

[8] We appreciate that this age range is arbitrary, but the contribution outside this age range is likely to include a social support services component, that we were unable to estimate.

these individuals would have incurred in future years had they lived to their expected age at death. As the current study includes the present value of the expected impact on future GDP of those who died prematurely from smoking attributable causes not participating in the workforce, it is appropriate to follow the practice of previous Australian cost of illness studies and offset against this loss of future economic output the expected present value of health expenditures averted due to the premature deaths. In this context averted future healthcare spending is treated as a benefit, as it does not have any utility attached to it by the consumer (in contrast to normal consumption spending where the value of the increase in utility to the consumer is at least as great as the spending).

As with the costs of lost economic output, the 'years of life lost' (YLLs) for each premature death were calculated using age, gender and Aboriginal and Torres Strait Islander specific estimates for years of life remaining from the Australian Bureau of Statistics' life tables (Australian Bureau of Statistics, 2013, 2018g)

Annual expected healthcare costs averted in 2015/16 were calculated by combining the estimated years of life lost by age in 2015/16 with data on average total health care expenditure per person (Australian Institute of Health and Welfare, 2017c) and the distribution of healthcare expenditure by age-group and gender (Australian Institute of Health and Welfare, 2010, pg.14). These costs were projected out over a 30-year analysis period by 'ageing' the cohort by one year in each period and applying the age-specific healthcare cost for the new age, together with the average real rate of per capita healthcare inflation over the five years to 2015/16 (Australian Institute of Health and Welfare, 2017c). Where the expected years of life remaining for the age as at 2015/16 indicated that an average individual of that age would only be alive for a fraction of a year, that fraction was applied to the cost estimate. Where the expected years of life estimate suggested that an average individual of that age would not be alive, then a cost of $0 was used.

The estimated total net present value (over 30 years using a seven per cent real discount rate) of healthcare costs avoided due to premature tobacco attributable mortality was a **saving of $2.3 billion**. (Also see section 4.5 for further discussion).

4.2.5 Stillbirths

The National Mortality Dataset includes neo-natal and post-natal deaths but not stillbirths. Smoking is a known risk factor for stillbirth, with an estimated relative risk of 1.46 in the presence of smoking during a pregnancy (English et al., 1995; Gakidou et al., 2017; GBD 2015 Tobacco Collaborators, 2017a; International Agency for Research on Cancer, 2012; US Department of Health and Human Services, 2004, 2006, 2014). Analysis of the National Perinatal Dataset data by the Cancer Council of Victoria indicates that the prevalence of smoking amongst pregnant women is 9.9 per cent (Greenhalgh et al., 2018), giving an attributable fraction for smoking of 4.4 per cent.

An Australian study (PwC, 2016) estimated that the total cost of stillbirths in Australia was $141.2 million in 2016 or $56,188 per case. There were an average of 2,133.5 stillbirths in Australia over the period 2014/15 to 2015/16 (Australian Institute of Health and Welfare, 2018b), with the estimated average number of smoking attributable cases of stillbirths being 92.9. Based on the PwC estimate of $56,188 per case, this would add a further **$5.2 million** to the tangible costs total.

4.3 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 value of a statistical life that was developed by Abelson (Abelson, 2008). Abelson recommended using a value of a statistical life 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 UK government and the European Union member countries.

The Abelson estimate was in 2007 values and needed to be converted to 2015/16 vales for this analysis. The rate at which a value of statistical life 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 Department of Transportation, 2015) in adopting a relatively conservative assumption of an income elasticity of 1 [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 value of a statistical life of $4.6 million.

Internationally, much higher values are often used reflecting the findings of studies into the value of a statistical life [10]. The US Department of Transportation used a value of a statistical life of US$9.1 million in 2013 values (US Department of Transportation, 2015). This was derived by averaging 15 hedonic wage studies (e.g. studies which estimate the wage premium demand by workers for more dangerous occupations and use the difference in annual mortality rates between industries to calculate the implicit value placed on a premature death). The US Environment Protection Authority also adopts a similar

[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).

approach, using a similar but slightly different value derived from a slightly different set of studies. Converting the US Department of Transportation VoSL estimate to Australian dollars using Purchasing Power Parity exchange rates (Organisation for Economic Cooperation and Development, 2016a), and then to 2015/16 values using the growth in per capita current prices GDP (Australian Bureau of Statistics, 2018b) from 2012/13 to 2015/16 gives a value of a statistical life of $13.6 million. This value is used as our high bound estimates.

There is a 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 year of life lost 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 for 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 statistical life year derived from Abelson (2008) updated to 2015/16 values (see below for the approach to this) 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 value of a statistical life 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 value of a statistical life 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, 2017c), 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 smoking attributable mortality we have estimated the cost using a value of a statistical life year approach.

Values of a statistical life year are derived from the value of a statistical life 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:

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

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 per cent per annum

r = the discount rate used, in this case seven per cent 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 value of a statistical life year is applied to the estimated potential years of life lost 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 seven per cent.

In order to ensure consistency with other estimates, we used the Abelson values for our main estimates, which gives an expected intangible cost of smoking attributable premature mortality in 2015/16 of **$92.1 billion**.

If, instead, the value of a statistical life estimate used by the US Department of Transportation (2015) were to be used, then the estimated intangible cost of smoking attributable premature mortality in 2015/16 would be $272.9 billion.

Finally, if intangible costs of premature mortality were valued based on potential years of life lost, then the intangible cost of smoking attributable premature mortality in 2015/16 would have an expected present value of $49.1 billion.

4.4 Total costs of premature mortality

Our central estimate of the cost of the estimated 20,032 smoking attributable premature deaths in 2015/16 is **$93.9 billion**, with net tangible costs of **$1.8 billion** and intangible costs of **$92.1 billion** if the Abelson (Abelson, 2008) value of a statistical life is used (see Table 4.4). As discussed in Section 4.1, because of the confidentialisation of the dataset undertaken by the AIHW, a number of smoking attributable deaths could not be included in the analysis. Thus, our estimated costs of mortality are likely to be underestimated.

The high bound estimates are calculated using the higher estimate of a value of a statistical life sourced from the US Department of Transport (US Department of Transportation, 2015). Using this value of a statistical life gives total expected net costs from premature mortality of $277.0 billion, with net tangible costs of $1.8 billion and intangible costs of $272.9 billion. The low bound estimate is calculated using

potential years of life lost, rather than a set cost per case of premature mortality, with years of life lost valued using a VoSLY derived from Abelson's (Abelson, 2008) value of a statistical life. Using this approach gives total expected net costs from premature mortality of $50.8 billion, with net tangible costs of $1.8 billion and intangible costs of $49.1 billion.

4.5 Conclusions

The long 'tail' of the tobacco epidemic is evidenced by the extent of premature mortality still attributed to smoking, despite the long-term decline in the prevalence of smoking in Australia. The exact quantum will vary with the method used, with estimates that there were 22,900 deaths in 2010 and 24,000 in 2015 (Peto et al., 2015) using one method, and 18,762 deaths in 2011 using another (Australian Institute of Health and Welfare, 2016b). The current estimate of 20,032 for 2015/16 shows the continuing toll on society from tobacco use. These deaths were estimated to have tangible net costs of nearly $1.8 billion with a further $92.1 billion in intangible costs.

Table 4.4: Social cost of tobacco attributable premature mortality, $ 2015/16

Costs	Central estimate	Low bound	High bound
Tangible costs			
NPV of lost economic output (non-employee)	3,388,405,429	3,388,405,429	3,388,405,429
Recruitment/training costs to employers	28,029,971	28,029,971	28,029,971
NPV of value of lost unpaid household work	623,688,044	623,688,044	623,688,044
NPV of healthcare costs avoided	-2,275,922,187	-2,275,922,187	-
Stillbirths (tangible costs)	5,219,865 [1]	5,219,865 [1]	5,219,865 [1]
Total net tangible costs	**1,769,421,122**	**1,769,421,122**	**4,045,343,309**
Intangible costs	**Abelson value of a statistical life [2].**	**Abelson value of a statistical life year [3]**	**US DoT value of a statistical life [4].**
Value of statistical life	92,108,544,749	49,058,706,233	272,906,689,958
Total tangible and intangible cost	**93,877,965,871**	**50,828,127,355**	**276,952,033,267**

US DoT = United States Department of Transport: VoSL = Value of a statistical life: VoSLY = Value of a statistical life year
Notes: [1] Based on the PwC estimate of $56,188 per case (PwC, 2016): [2] VoSL $4.6 million (Abelson, 2008): [3] VoSLY $286,553, based on the Abelson value of a statistical life: [4] $13.6 million (US Department of Transportation, 2015)

4.6 Limitations

Our reference population of daily smokers in 2016 (or in the case of those conditions with longer lead-times, those who were daily smokers five years ago) will exclude some of the harms of smoking as, for some of the smoking attributable conditions, the risks diminish but are not always removed completely once smoking ceases. This is likely to particularly affect conditions such as ischaemic heart disease that tend to occur relatively later in life, when many of those who were daily smokers at some point in their lives have successfully quit, but where ex-smokers still have significantly elevated risks for some years. Even for those conditions with very long lead-times, such as cancers and COPD, where the SIR approach is used, this limitation is not completely addressed, as the reference data for the SIR calculation is the ratio of lung cancer rates amongst current and never smokers in the CPS-II population, again excluding harms to ex-smokers in that population.

As noted above, in order to ensure confidentiality, we excluded any cell with fewer than five deaths from the analysis, which will therefore underestimate the total number of attributable deaths. To minimise this, we requested data in 10- to 20-year age blocks for the data that separately identified Aboriginal and

Torres Strait Islander and non-Aboriginal and Torres Strait Islander deaths. However, this will result in less accurate estimates of the number of PYLL.

There is currently no consensus on the most appropriate approach to measuring the costs to society of stillbirths, with existing studies limited to valuing tangible impacts, with measures of the intangible costs a particular gap in the evidence base. However, research by Ogwulu and colleagues has expanded the evidence on the nature and scale of the psychological impact on parents (Campbell et al., 2018; Heazell et al., 2016; Ogwulu et al., 2015; PwC, 2016).

Even within estimates of tangible costs, a range of approaches have been taken to the inclusion of cost items. A recent Australian study (PwC, 2016) focussed on the tangible impacts on the parents of the stillborn child, identifying impacts on their productivity in the workplace (including absenteeism and 'presenteeism') medical and counselling costs, and funeral costs, as well as less direct impacts such as the cost of increased divorce rates subsequent to a stillbirth. In contrast, a UK based study (Campbell et al., 2018) did not include productivity impacts on the parents of the stillborn child (only measuring absenteeism, estimated at GBP 2,476). Their estimated cost of stillbirth was driven by the present value of expected future earnings had the stillborn child survived, with a cost per case of GBP 213,304. Combined with other medical and counselling costs associated with stillbirth this gave a total estimated cost of GBP 222,660 per stillbirth in 2013/14 terms. Therefore, the figure included in the current analysis for stillbirths should only be regarded as a preliminary estimate.

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CHAPTER 5: HOSPITAL INPATIENT MORBIDITY

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5.1 Introduction

As documented in Chapter 3 (Table 3.1), smoking is associated with a plethora of adverse health outcomes and therefore costs arising from the use of health services in treating these conditions. This chapter focuses on the hospital inpatient costs of smoking. Chapter 6 addresses other health costs such as excess emergency department, outpatient treatment, general practitioner visits, nursing home care and medications.

A recent Canadian analysis reported that health care costs were the largest cost area attributed to smoking tobacco, representing nearly 50 per cent of the total tangible cost of smoking, with inpatient care accounting for almost 30 per cent of health care costs (CAD 1.6 billion out of CAD 5.9 billion) (Canadian Substance Use Costs and Harms Scientific Working Group, 2018). In contrast, Collins and Lapsley's 2004/05 Australian study found that health care in general accounted for a far smaller proportion of tangible costs (2.6 %, $318.4 million out of $12.0 billion), although hospital costs were the single largest item within health care (70 %, $223.4 million) (Collins and Lapsley, 2008). Using an alternative approach to the method of Collins and Lapsley (2008), an analysis of costs in the Northern Territory found that health care represented 17 per cent of total tangible costs, with inpatient care being 45 per cent of these costs ($16.0 million of $35.6 million) (Whetton et al., 2013).

The current study broadly follows the approach adopted in the recent Australian study into the social cost of methamphetamine (Whetton et al. 2016), but with some refinements developed in a recent study into the social and economic costs of alcohol in the Northern Territory (Smith et al., 2019).

5.2 Method

Hospital costs due to smoking are calculated from the number of tobacco attributable hospital separations and the cost of those separations. The set of conditions partially caused or prevented by smoking used in the analysis of hospital separations is set out in Section 3.1.

Tobacco attributable separations are estimated using the attributable fraction method described in Chapters 2 and 3, and data on the number of separations by ICD-10 code provided by the AIHW from the National Hospital Morbidity Database (Australian Institute of Health and Welfare, 2019) for those conditions that could potentially be caused or prevented by smoking. The relevant public and private hospital separations were disaggregated between those where the patient was identified in the data as Aboriginal and Torres Strait Islander, and those where the patient was not identified as Aboriginal and Torres Strait Islander. Aboriginal and Torres Strait Islander identification for hospital separations that occur in Victoria and the Australian Capital Territory is regarded as unreliable and so these jurisdictions are excluded from the data on Aboriginal and Torres Strait Islanders.

In 2015/16, total expenditure on hospital care in Australia was estimated to be $28.3 billion (Independent Hospital Pricing Authority, 2018). As part of the process of being admitted to and leaving hospital (being discharged or dying), records for each patient include an AR-DRG code which identifies the type of treatment and hospital services delivered to that patient for each episode of care. These AR-DRG codes

can be used to identify the average cost of care by linking data on hospital separations with data from the Independent Hospital Pricing Authority (Independent Hospital Pricing Authority, 2015) on the 'cost weight' for that treatment (that is the cost of that episode as a proportion of the average cost of a hospital separation). We then multiplied that cost weight by the average cost of an acuity adjusted hospital separation. In 2015/16 the average cost of an acuity adjusted hospital separation was $5,194 (Independent Hospital Pricing Authority, 2018). To illustrate the approach, separations with the AR-DRG 'A03Z: Lung or Heart-Lung Transplant' have an average cost weight of 21.4519, and an expected average cost of $111,528.4 per separation (e.g. $5,194 times 21.4519). These individual costs are then summed across all of the smoking attributable separations with that principal diagnosis and adjusted by the attributable fractions listed in Table 3.1 to give the total cost attributable to smoking.

For those ICD-10 codes with multiple entries in the relative risks table (Table 3.1) – for example asthma due to the different aetiology of childhood, adolescent and adult asthma, and those conditions which can be caused by both smoking and exposure to secondhand smoke – the AFs were calculated separately using the relevant prevalence measure, and then summed for the hospital costs calculation.

The separations data were coded in five-year age-groups, with separations at age 0 (less than 12 months) reported separately. Age-groups for those not identified as Aboriginal and Torres Strait Islanders extended up to age 70-74, with all ages beyond that age grouped as 75+. Age-groups for those identified as Aboriginal and Torres Strait Islanders extended up to age 60-64, with all ages beyond that age grouped as 65+ years.

Hospital separations data are for all relevant separations that occurred in Australia in 2015/16, although 194 cases where the AR-DRG code is missing are not included in the analysis.

The hospital separations for conditions that are potentially smoking attributable were combined with the relevant attributable fractions by five-year age-group, gender, and Aboriginal and Torres Strait Islander identification to yield ***smoking-attributable*** hospital separations for each ICD-10 code. Where a net protective effect from tobacco exists for a demographic group, the calculated hospital separations are negative.

Separations reported against the ICD-10 codes for radiotherapy sessions (Z51.0) or pharmacotherapy sessions (Z51.1) for cancers attributable to smoking were given an attributable fraction based on the weighted average of all smoking attributable cancers in the data.

'Injury' separations such as burns and fractures were attributed to smoking based on their secondary codes.

5.3 Results

There were 138 ICD-10 codes for conditions potentially partially caused or prevented by smoking or exposure to secondhand tobacco smoke with at least one hospital separation in the dataset for 2015/16. There were just over 1.7 million hospital separations for these conditions in 2015/16 out of a total of nearly 10.6 million, including both public and private hospitals (Australian Institute of Health and Welfare, 2017b). Across all conditions, the total cost of hospital separations caused by smoking in 2015/16 was $1.5 billion. Conditions where smoking has a partially preventative effect resulted in cost savings of $6.9 million, giving a net cost of smoking attributable hospital separations of **$1.5 billion** (Table 5.1).

Chronic obstructive pulmonary disease was the most costly condition caused by smoking, with total costs of $347.3 million, followed by ischaemic heart disease ($205.9 million) and tracheal, bronchus, and lung cancer ($152.8 million). Other diseases that imposed substantial costs included stroke ($106.5 million), low birthweight ($90.5 million) other CVD and circulatory diseases ($69.4 million), influenza and pneumonia ($48.0 million), hip fracture ($38.7 million), kidney and bladder cancer ($36.4 million), oesophageal cancer ($18.8 million) and pancreatic cancer ($13 million).

Fifty-nine per cent of the net costs ($900.1 million) relate to hospital separations by males. Those identified as Aboriginal and Torres Strait Islanders are overrepresented in the hospital separations data accounting for 5.9 per cent of smoking attributable hospital separation costs (and 7.2 % of the hospital separations cost amongst females).

Avoided costs are low compared to health costs caused by smoking as there are only three conditions for which there is robust evidence for a protective effect from smoking: Parkinson's disease; endometrial cancer; and, hypertension in pregnancy. Ulcerative colitis was included in Collins and Lapsley (Collins and Lapsley, 2008) as a condition for which smoking had a protective effect, but studies published since then have generally found no such effect (US Department of Health and Human Services, 2014).

Table 5.1: Cost of smoking attributable hospital separations in 2015/16, caused and prevented, by gender and Aboriginal and Torres Strait Islander identification, $ 2015/16

Condition	ICD 10 code	Not identified as Aboriginal or Torres Strait Islander		Identified as Aboriginal or Torres Strait Islander †		Total population
		Male	Female	Male	Female	
Tuberculosis	A15	312,976.8	160,643.6	31,478.1	26,422.3	531,520.8
	A16	98,963.9	92,181.9	15,278.9	5,316.2	211,740.9
	A19	46,403.5	14,751.7	0.0	0.0	61,155.2
Lip and oral cavity cancer	C00	1,049,599.1	454,476.7	39,133.7	6,118.3	1,549,327.8
	C01	4,731,334.9	1,194,738.5	350,536.5	67,415.8	6,344,025.8
	C02	4,612,021.8	3,777,165.0	111,994.7	134,340.7	8,635,522.2
	C03	1,025,176.7	1,181,074.1	0.0	41,125.1	2,247,376.0
	C04	2,695,343.7	1,279,656.6	118,441.4	157,971.3	4,251,412.9
	C05	794,566.2	608,053.5	106,158.8	5,813.5	1,514,592.0
	C06	2,232,964.2	1,110,756.9	197,724.6	28,955.6	3,570,401.2
	C07	3,890,692.6	817,971.5	0.0	20,262.6	4,728,926.7
	C08	494,357.2	286,661.3	58,516.2	0.0	839,534.7
	C09	3,569,559.0	735,152.0	158,148.7	82,993.6	4,545,853.3
	C14	620,810.1	146,803.8	84,598.9	4,314.0	856,526.9
Nasopharynx cancer	C10	1,590,001.2	541,746.7	122,703.5	11,447.3	2,265,898.7
	C11	1,012,261.8	313,659.5	21,409.8	3,461.4	1,350,792.6
	C12	1,752,736.6	149,833.3	20,903.1	81,497.1	2,004,970.1
	C13	1,305,383.4	262,277.9	159,484.3	0.0	1,727,145.6
Oesophageal cancer	C15	13,667,579.0	4,457,024.3	439,910.0	192,606.7	18,757,120.0
Stomach cancer	C16	5,108,254.6	1,613,618.5	126,598.1	63,798.7	6,912,269.8
Colon and rectum cancer	C18	6,744,833.7	9,075,034.9	140,163.9	319,703.4	16,279,735.9
	C19	1,492,930.6	1,459,311.0	56,938.0	46,308.7	3,055,488.4
	C20	2,661,104.4	2,005,497.4	64,973.7	41,857.3	4,773,432.8
Liver cancer	C22	3,569,257.7	1,399,428.2	236,267.5	125,490.6	5,330,444.0
Pancreatic cancer	C25	7,260,833.2	5,384,392.6	221,364.4	222,592.3	13,089,182.5
Cancer of nasal cavity	C30	309,573.1	309,473.8	8,237.3	0.0	627,284.2

Condition	ICD 10 code	Not identified as Aboriginal or Torres Strait Islander		Identified as Aboriginal or Torres Strait Islander †		Total population
		Male	Female	Male	Female	
Larynx cancer	C32	10,502,888.4	1,432,531.7	515,006.3	258,856.7	12,709,283.1
Tracheal, bronchus, and lung cancer *	C34	88,428,357.2	59,853,006.8	2,810,441.3	1,670,775.9	152,762,581.2
Cervical cancer	C53	n/a	716,501.9	n/a	181,537.0	898,038.9
Endometrial cancer (protective)	C54.1	n/a	-1,992,644.9	n/a	-423,046.6	-2,415,691.6
Kidney cancer	C64	7,511,154.3	1,861,775.2	257,460.4	122,101.7	9,752,491.6
	C65	927,936.8	361,338.0	53,811.4	1,061.6	1,344,147.9
Bladder cancer	C66	1,209,117.4	537,924.7	23,620.4	36,020.6	1,806,683.1
	C67	18,378,291.9	4,644,520.8	287,233.1	169,283.7	23,479,329.6
Acute myeloid Leukaemia	C92	7,601,670.1	1,254,553.2	136,446.2	117,538.2	9,110,207.6
Diabetes mellitus type 2	E11	8,443,402.5	729,185.7	1,451,792.9	288,185.3	10,912,566.4
Parkinson's disease (protective)	G20	-1,848,969.8	-748,474.6	-37,556.7	-14,347.3	-2,649,348.3
Cataract	H25	2,249,289.8	2,194,559.4	26,037.3	35,739.9	4,505,626.4
	H26	16,954,252.0	16,209,230.6	300,757.0	456,311.1	33,920,550.7
Macular degeneration	H35.3	6,629,761.6	6,243,448.0	33,016.3	50,801.8	12,957,027.6
Otitis media (secondhand smoke)	H65	795,411.1	501,068.5	39,564.8	32,365.2	1,368,409.6
	H66	278,147.4	194,312.0	25,014.2	15,647.2	513,120.7
Hypertensive heart disease	I11	199,977.5	104,642.1	30,152.2	24,151.8	358,923.6
Ischaemic heart disease*	I20	24,833,007.5	10,307,590.8	1,465,154.3	1,312,197.1	37,917,949.7
	I21	61,566,440.9	21,357,598.9	5,115,726.6	3,617,388.2	91,657,154.6
	I22	151,473.4	43,645.3	6,994.9	14,733.5	216,847.1
	I23	96,950.8	53,249.8	5,297.0	24,291.8	179,789.3
	I24	207,393.3	96,727.2	21,831.6	21,166.4	347,118.5
	I25	56,295,251.1	14,753,927.6	2,905,373.7	1,626,529.6	75,581,082.0
Other cardiovascular and circulatory diseases	I46	2,871,072.0	1,130,515.4	333,187.0	245,867.4	4,580,641.7
	I47	6,615,233.0	4,276,199.8	230,959.7	156,550.3	11,278,942.8
	I49	5,911,149.8	3,078,024.6	201,049.9	161,428.6	9,351,653.0
	I50	25,180,136.7	12,362,589.0	2,414,843.6	2,072,525.3	42,030,094.5
	I51	1,543,565.0	572,803.5	46,922.1	12,612.9	2,175,903.5
Atrial fibrillation and flutter	I48	18,657,270.0	8,492,211.6	661,998.9	540,856.4	28,352,336.9
Haemorrhagic stroke *	I60	6,849,738.1	12,484,700.0	316,752.2	458,310.4	20,109,500.7
	I61	9,162,917.5	7,163,281.4	481,200.9	559,425.2	17,366,825.0
	I62	3,120,301.4	2,219,909.7	197,525.3	178,612.5	5,716,348.9
Ischaemic stroke *	I63	26,778,238.1	19,780,277.3	1,103,874.3	1,311,935.7	48,974,325.4
	I64	4,473,098.5	3,580,102.4	169,708.8	296,670.8	8,519,580.5
	I65	2,538,147.9	1,149,167.2	36,447.3	76,594.7	3,800,357.1
	I66	992,535.6	934,399.1	26,807.3	45,276.8	1,999,018.9
Cerebrovascular disease (secondhand smoke)	I67	2,959,520.2	171,227.6	81,439.8	305,706.2	3,517,893.8
Atherosclerosis	I70	18,703,663.9	6,451,391.3	744,232.3	474,759.8	26,374,047.4
Aortic aneurysm	I71	10,525,952.3	2,421,896.4	228,549.4	80,954.2	13,257,352.2
Peripheral vascular disease	I72	2,900,621.8	1,250,973.2	138,894.4	105,039.4	4,395,528.8
	I74	1,889,958.9	968,991.8	145,158.7	129,081.6	3,133,191.0
Other cardiovascular and circulatory diseases	I77	1,271,493.6	992,280.0	35,333.5	52,855.9	2,351,963.1
	I78	234,639.6	287,756.4	0.0	5,186.6	527,582.5
Influenza and pneumonia *	J10	1,497,116.3	1,812,895.1	94,964.5	211,884.7	3,616,860.6
	J11	107,814.4	145,112.4	6,104.1	18,792.2	277,823.2
	J12	1,524,291.6	1,652,519.2	138,574.9	199,148.0	3,514,533.7
	J18	19,649,194.5	16,345,828.3	1,783,426.7	2,874,562.5	40,653,012.0

Condition	ICD 10 code	Not identified as Aboriginal or Torres Strait Islander		Identified as Aboriginal or Torres Strait Islander †		Total population
		Male	Female	Male	Female	
Lower respiratory illness (child)	J13	8,202.3	6,994.1	1,202.4	1,801.0	18,199.8
	J14	2,113.1	1,807.6	1,209.5	94.0	5,224.3
	J15	57,369.0	59,037.4	11,215.0	2,440.8	130,062.1
	J16	810.0	748.0	0.0	62.4	1,620.4
	J17	587.1	1,570.9	0.0	0.0	2,158.0
	J20	12,758.9	12,741.2	2,806.5	1,495.8	29,802.4
	J21	1,070,917.7	681,542.2	142,717.4	93,219.5	1,988,396.8
	J22	138,836.5	113,339.9	22,260.8	15,389.4	289,826.6
Chronic obstructive pulmonary disease	J43	1,043,324.0	1,086,841.1	55,636.8	270,831.1	2,456,633.2
	J44	154,600,828.4	162,552,001.0	8,747,808.6	14,373,326.2	340,273,964.1
Asthma*	J45	2,286,044.5	3,811,249.3	229,907.8	706,986.7	7,034,188.4
	J46	340,330.5	461,759.0	63,075.0	102,211.0	967,375.4
Other chronic respiratory diseases	J47	1,589,845.6	4,027,164.4	620,342.7	329,836.2	6,567,189.0
	J70	229,525.3	222,654.3	21,976.9	0.0	474,156.5
	J80	320,057.4	116,948.9	52,281.1	3,142.4	492,429.9
	J81	266,921.1	322,313.7	91,125.6	90,118.0	770,478.5
	J82	102,676.2	117,304.5	0.0	1,842.9	221,823.5
	J85	501,577.0	327,668.6	103,144.6	216,134.5	1,148,524.6
	J86	1,050,871.4	495,073.1	101,408.3	31,009.7	1,678,362.6
	J90	6,381,358.2	3,909,371.8	167,385.2	226,613.8	10,684,728.9
	J93	1,555,457.9	820,635.6	201,068.8	97,199.3	2,674,361.5
	J94	486,173.7	216,923.4	10,326.6	0.0	713,423.7
	J96	5,510,551.5	5,104,766.3	485,111.9	603,747.1	11,704,176.7
	J98	1,410,345.0	1,488,357.2	92,814.6	144,259.4	3,135,776.2
Peptic ulcer disease	K25	2,095,884.9	1,457,889.4	142,577.9	107,924.8	3,804,277.0
	K26	2,690,396.8	1,190,082.8	225,060.4	117,132.7	4,222,672.7
	K27	111,190.6	87,207.7	11,344.6	12,871.3	222,614.1
Rheumatoid arthritis	M05	57,221.7	88,015.0	1,130.3	4,689.0	151,056.0
	M06	513,619.7	1,329,165.7	19,751.8	51,592.5	1,914,129.7
Erectile dysfunction	N484	110,979.1	n/a	509.0	n/a	111,488.2
Reduced fertility in women	N97	n/a	2,136,802.9	n/a	111,179.0	2,247,981.9
Ectopic pregnancy	O00	n/a	1,141,531.7	n/a	68,749.3	1,210,281.0
Miscarriage	O03	n/a	790,452.1	n/a	35,799.3	826,251.4
Hypertension in pregnancy (protective)	O10	n/a	-82,051.9	n/a	-6,357.8	-88,409.7
	O11	n/a	-106,758.2	n/a	-7,354.2	-114,112.4
	O12	n/a	-11,470.0	n/a	-2,845.1	-14,315.1
	O13	n/a	-471,862.6	n/a	-23,411.6	-495,274.2
	O14	n/a	-923,042.1	n/a	-72,555.3	-995,597.5
	O15	n/a	-13,491.9	n/a	-2,412.1	-15,904.0
	O16	n/a	-106,906.3	n/a	-7,628.3	-114,534.5
Premature rupture of membranes	O42	n/a	2,035,025.3	n/a	173,227.4	2,208,252.7
Placenta previa and other antepartum haemorrhage	O44	n/a	834,941.3	n/a	42,773.0	877,714.3
	O45	n/a	137,719.4	n/a	6,884.2	144,603.7
	O46	n/a	1,233,555.6	n/a	74,305.4	1,307,861.1
Low birthweight[a]	P05, P06	46,100,488.5	38,057,638.5	3,493,112.9	2,883,692.4	90,534,932.3
Orofacial clefts (secondhand smoke)	Q35	63,144.5	53,911.5	4,673.2	7,181.3	128,910.5

Condition	ICD 10 code	Not identified as Aboriginal or Torres Strait Islander		Identified as Aboriginal or Torres Strait Islander †		Total population
		Male	Female	Male	Female	
	Q36	47,987.9	21,286.6	2,143.6	1,101.5	72,519.6
Non-Hip Fracture	S02	1,385,881.7	427,073.4	271,171.5	85,282.0	2,169,408.5
	S12	741,215.5	270,888.0	34,526.5	24,153.2	1,070,783.2
	S22	2,061,208.1	997,024.3	122,792.3	61,698.7	3,242,723.3
	S42	1,884,672.6	1,632,916.0	85,768.8	63,623.9	3,666,981.3
	S52	1,869,581.1	2,527,854.6	112,652.7	113,118.8	4,623,207.2
	S82	4,018,866.4	3,529,411.0	341,223.9	260,900.6	8,150,402.0
	S92	760,008.8	362,262.4	38,036.5	26,688.2	1,186,995.9
Hip Fracture	S72	16,162,650.0	21,307,027.5	445,732.3	818,012.1	38,733,421.9
Fire injuries	T20	386,013.0	100,653.4	11,452.9	3,769.0	501,888.2
	T21	540,903.9	218,789.4	62,788.0	1,058.7	823,540.0
	T22	359,300.0	91,822.4	42,158.6	32,344.7	525,625.7
	T23	201,583.4	34,049.4	16,026.3	20,211.6	271,870.8
	T24	635,423.1	107,349.1	22,879.5	17,745.5	783,397.2
	T25	89,234.4	32,256.4	10,184.6	4,885.2	136,560.7
	T26	3,851.6	580.5	580.5	0.0	5,012.6
	T27	33,964.0	30,163.2	0.0	0.0	64,127.2
	T28	196.1	11,449.5	0.0	0.0	11,645.6
Cancer treatment nes	Z51.0	80,399.9	658,559.2	0.0	3,536.7	742,495.8
	Z51.1	32,937,913.9	19,640,570.4	409,888.3	314,143.1	53,302,515.7
Total prevented		**-1,848,969.8**	**-4,456,702.5**	**-37,556.7**	**-559,958.3**	**-6,903,187.3**
Total caused		856,778,628.2	580,542,515.6	45,172,644.3	45,203,171.2	1,527,696,959.3
Total net cost		854,929,658.4	576,085,813.0	45,135,087.7	44,643,212.9	1,520,793,772.0

* Some of the separations for this condition arise from exposure to secondhand smoke.

† The results do not include Victoria or Australian Capital Territory, as identification data are not regarded as reliable.

[a] The number of separations from low birthweight were taken from AIHW. Undated. 'Principal Diagnosis data cube under ICD-10-AM Edition 9, 2015-16'. Allocation between Aboriginal and Torres Strait Islanders and other Australians was made based on data on the relative proportion of live births with birthweight below 2,500g from AIHW. 2018 Australia's mothers and babies 2016.

n/a = not applicable e.g. sex specific conditions: nes = not elsewhere specified

5.4 Conclusions

As anticipated, conditions attributed to smoking had a substantial net cost in terms of hospital separations, with the estimate being $1.52 billion for 2015/16. In 2004/05, the net cost of tobacco attributable hospital separations was estimated to be $669.6 million (Collins and Lapsley, 2008): after adjusting for the change in the average national cost of an acuity adjusted hospital separations between 2004/05 and 2015/16 (Department of Health and Ageing, 2006; Independent Hospital Pricing Authority, 2018) this would be equivalent to $1.0 billion in 2015/16 costs or about two thirds of the current net total of $1.52 billion. The list of health conditions attributable to smoking in the current work was more extensive than the list used in the earlier study, and a number of the relative risk estimates have also been amended. For example, the addition of codes C18-C20 (colon and rectal cancers) added $16 million to our total, with diabetes type 2 (E11) adding over $10 million, cataracts (H25-H26) over $38 million and liver cancer a further $5.3 million. Improved understanding of the harms due to smoking is likely to further increase estimates of associated health-care costs, even though the prevalence of smoking continues to decline.

5.5 Limitations

The identification of all hospital separations by Aboriginal and Torres Strait Islander peoples was not possible for data from Victoria and the ACT, so the results will under-estimate the harms to these populations. We have included the hospital cost of miscarriages in this analysis ($826,251) although the cost of these separations is less than would have occurred had the pregnancy gone to a subsequent uncomplicated vaginal birth. The rationale is a combination of the fact that expenditure on miscarriages is expenditure to address an undesired health state and therefore is different from expenditure on a live birth, and also that a portion of those who suffer a miscarriage will go on to have an additional pregnancy that they would not have had, if they had not suffered a miscarriage. Thus, a miscarriage does not necessarily result in lower costs than a live birth. An additional factor not included in our analyses is the long-term cost of prenatal exposure to smoking. A recent Australia study reported that the cost of each exposed infant was $29,000 over their lifetime and if smoking in pregnancy was eliminated, the total savings would be nearly $1 billion (PWC, 2019). Consistent with other sections of the report, the focus was on costs in the target year, but it is important to note that low birthweight babies, not only have higher costs at the time of birth, with a Canadian report that just neonatal care of a low birthweight infant cost CAD 52,000, but that they have on-going hospital costs too (Mirolla, 2004; Petrou et al., 2005).

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CHAPTER 6: PRIMARY CARE & NON-ADMITTED PATIENT HEALTH COSTS

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6.1 Introduction

As a result of health conditions either wholly or partially caused by smoking, smokers will use many types of health services, including hospital emergency department and outpatient services, general practice, referred specialist care, ambulance services, nursing homes and other carer services. In addition, smokers are likely to incur further costs in purchasing smoking cessation therapies and pharmaceuticals for the treatment of smoking-related conditions. The adverse health conditions incurred by smokers are also likely to have impacts on other family members. The costs arising from inpatient admissions are addressed in Chapter 5.

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

Correct apportionment of these costs to smoking-related conditions is an important element in estimating the overall cost to Australia. However, for most of these costs, such as general practitioner services, there is no unambiguous means of attributing costs to smoking as there is no consistent and reliable equivalent to the ICD-10 coding use for hospital separations. Previous Australian studies, in the absence of data on the conditions responsible for use of other healthcare, assumed that the proportion of other health costs attributable to smoking could be reasonably approximated by the proportion of hospital bed-days attributed to smoking on the assumption that they had a similar distribution of underlying causes (Collins and Lapsley, 2008; Whetton et al., 2013).

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 entirely unrelated to those which cause hospital separations, such as renewal of prescriptions, general health check-ups, vaccinations etc.

Some component of allied health expenditure must be attributable to smoking. This would include dental care caused by smoking attributable periodontitis, implant failure and possibly also dental caries. Costs of physiotherapy not delivered through hospital outpatient services might also be attributed to smoking for a high proportion of patients post-stroke and hip replacement. Fractures and wounds take longer to heal in smokers than non-smokers (US Department of Health and Human Services, 2014) and this may also result in greater use of physiotherapy and community nursing services. None of these forms of allied health expenditure potentially attributable to smoking are able to be quantified using current data and so no allied health spending has been included here.

This leaves the following areas of other healthcare costs for inclusion in this analysis.

Other medical costs, which comprise:

- Ambulance costs;
- Non-admitted hospital care costs (emergency department use and outpatient service delivery);
- Primary healthcare costs, including GP visits and specialist visits;
- Pharmaceuticals for smoking attributable diseases; and,
- Smoking cessation therapies.

And long-term care costs:

- Nursing home costs;
- Other aged care services; and,
- Costs to family members of providing care.

In each of these cases, we have taken the share of smoking attributable hospital costs as the base for smoking attribution, and 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). Smoking attributable hospital separations are estimated to have had a total net cost of $1.5 billion, giving a cost share of 5.4 per cent. This then represents a base cost share for other medical costs, to be adjusted based on other evidence on the source of costs.

6.2 Non-admitted patient medical costs

6.2.1 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 smoking should provide a reasonable proxy for the proportion of ambulance costs that can be attributed to smoking.

Total 'patient transport' expenditure in 2015/16 was $3.7 billion (Australian Institute of Health and Welfare, 2017c). Applying the cost share from the hospital separations data, this suggests that the smoking attributable cost of ambulances was **$200.2 million**.

5.2.2 Emergency department and outpatient costs

Given the similarity of the population they serve, as with ambulance costs, the proportion of non-admitted hospital care costs attributable to specific causal factors is likely to be broadly similar to that of hospital separations. Therefore, the proportion of hospital separation costs attributable to smoking should provide a reasonable proxy for the proportion of non-admitted emergency department costs and the proportion of outpatient costs that can be attributed to smoking.

This attribution may be less accurate for outpatient care costs, as in the 2015/16 data the total cost of outpatient care includes community mental health service events (Independent Hospital Pricing Authority, 2018, p. 29). If community mental health service events are more frequent in the outpatient data than acute mental health separations are in the hospital separations data, then our approach may overstate the proportion of outpatient care costs attributable to smoking.

Total expenditure in 2015/16 on emergency department 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 this suggests that the smoking attributable cost of emergency department presentations was **$252.7 million**.

Total expenditure in 2015/16 on outpatient care episodes was $5.4 billion (Independent Hospital Pricing Authority, 2018). Applying the cost share from the hospital separations data, this suggests that the smoking attributable cost of outpatient care episodes was **$289.3 million**.

6.2.3 Primary healthcare costs

There are a number of reasons for seeing a GP or other primary care physician which are largely unrelated to those for which patients are admitted to hospital. 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 per cent 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 per cent of this spending excluded as it related to ineligible costs identified from the BEACH data (Australian Institute of Health and Welfare, 2017c)). Applying the cost share from the hospital separations data, this suggests that the smoking attributable cost of 'un-referred medical services' was **$508.2 million**.

There is some recent evidence that, contrary to our assumption, and to conclusions of previous studies, smokers may not have an excess usage of primary healthcare (Mishra et al., 2016; Schlichthorst et al., 2016) (see the limitations section for a more extensive discussion). We have therefore adopted a low bound estimate which assumes that there are no excess smoking-related un-referred medical services expenditure.

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

Applying the cost share from the hospital separations data to the unadjusted referred medical costs gives a central estimate of smoking attributable costs of **$949.9 million,** and a low bound, calculated from the adjusted spending, of $765.7 million.

6.2.4 Costs of pharmaceuticals prescribed for selected smoking attributable diseases

Pharmaceuticals used in treating smoking-related conditions, received while an inpatient, are included within the costs derived from diagnosis-related groups codes, and form part of the costs reported in Chapter 5. Cost for treatment of smoking-related conditions outside the hospital system does need to be estimated. Previous analyses have calculated the net cost of these treatment services to account for

premature mortality among smokers, that is, subtracting saving from premature deaths among smokers In 2004/05 the gross costs of pharmaceuticals was $205.2 million, but after adjustment, the net cost of prescription pharmaceuticals received outside hospital was $77.3 million (Collins and Lapsley, 2008). In the current report, all averted medical costs, due to premature smoking attributable deaths, including pharmaceuticals are included in the mortality cost estimate (Chapter 4), and so, to avoid double counting, these notional future cost savings are not included here.

Our preferred approach to calculating smoking attributable pharmaceutical costs is to calculate it on a substance specific basis. First, lists produced by the Health Insurance Commission of the 50 most expensive and the 50 most frequently prescribed PBS items were inspected to identify medications used to treat smoking-related conditions (Pharmaceutical Benefits Scheme, 2016c, d). The conditions identified through this process were: "wet" macular degeneration, chronic obstructive pulmonary disease (± asthma), asthma, type 2 diabetes, heart disease, rheumatoid arthritis, peptic ulcer and prevention of stroke in people with atrial fibrillation, plus some heart disease medications (statins, beta-blockers and angiotensin converting enzyme (ACE) inhibitors).

The list of PBS medications for chronic obstructive pulmonary disease (COPD) with or without asthma was obtained from a post-market PBS review of COPD and asthma medications (Pharmaceutical Benefits Scheme, 2018c). The medications for diabetes type 2 were identified through another PBS post-market review (Pharmaceutical Benefits Scheme, 2014) and a report analysing the drugs used for diabetes management (Pharmaceutical Benefits Scheme, 2013). The drugs used for wet macular degeneration were identified via the PBS website for drugs under the category of ocular vascular disorder agents (Pharmaceutical Benefits Scheme, 2018a). Drugs used to treat rheumatoid arthritis were identified from the Medicare website (Medicare Australia, 2019) and from a clinical review of biological disease-modifying anti-rheumatic drugs (bDMARDs) (Pharmaceutical Benefits Scheme, 2009). Peptic ulcers drugs were identified using the PBS website by looking at the items that fall under the category of drugs for peptic ulcer and gastro-oesophageal reflux disease (GORD). Therefore, it does include cost of medicines for patients who suffer from GORD only and thus will over-estimate this cost. Stroke prevention drugs were identified using guidelines for the management of atrial fibrillation (American College of Cardiology, 2018). For each medication listed in Appendix Chapter 6.1, 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) (Table 6.1).

We did not have access to age-group, sex or Indigenous status for the PBS costs and so could not apply the smoking attributable fractions for each condition directly to pharmaceutical costs. Instead we assumed that the proportion of pharmaceutical cost for each condition attributable to smoking would be equivalent to the proportion of total hospital separation costs attributable to smoking for that condition, which is effectively the age, gender, Aboriginal and Torres Strait Islander status and severity weighted attributable fraction for that condition.

To calculate the cost of medicines associated with COPD, we had to adjust for the fact that the majority of COPD and asthma medications consumers are patients who suffer from asthma only. The COPD-asthma overlap rate suggested in the literature is around 20 per cent (Gibson and McDonald, 2015). Therefore, to calculate the total cost of COPD medications, we used the cost of COPD only medicines and added 20 per cent of total cost for asthma and COPD medications as the total cost of pharmaceuticals (Table 6.1). To calculate the cost of asthma, we took 80 per cent of total cost of asthma and COPD medications. We then respectively applied the proportion of hospital separation costs attributable to

smoking for each condition included in Table 6.1. This gives a total cost of smoking attributable PBS listed medicine costs for the selected conditions of **$451.1 million** (Table 6.2).

Table 6.1: The costs of medications* for key smoking-related conditions

Condition	Total cost ($)
('wet') Age-related macular degeneration, diabetic macular	483,377,565
Chronic obstructive pulmonary disease (excluding asthma)	246,215,672
Asthma	343,106,743
Diabetes type 2	612,799,401
Stroke prevention in people with atrial fibrillation	378,599,364
Cardiovascular disease (statins, beta blockers and ACE inhibitors)	558,285,942
Rheumatoid arthritis	946,230,594
Peptic ulcer	392,393,422

**For individual items number see Appendix Chapter 6.1*

Table 6.2: Estimated smoking attributed costs of PBS / RPBS medications

Condition	Smoking attributable hospital separation costs (%)	Smoking attributable PBS medicine costs ($)
Macular degeneration	6.0	29,027,407
Chronic obstructive pulmonary disease	66.9	164,616,587
Asthma	10.9	37,263,856
Diabetes type 2	3.8	23,134,275
Stroke prevention in people with atrial fibrillation	13.0	49,321,099
Cardiovascular disease	12.2	68,261,968
Rheumatoid arthritis	4.1	39,189,652
Peptic ulcer	10.3	40,302,834
Total		**451,117,678**

The costs presented in the tables above only include cost of prescribed medications outside the hospital sector. Therefore, the total estimate does not include in-patient pharmaceutical costs (these are included in the hospital separation costs reported in Chapter 5) nor does it include pharmaceuticals delivered through outpatient hospital clinics (as is the case with a significant proportion of dialysis and chemotherapy). These latter costs should be captured in the outpatient hospital costs calculated above. The calculation also excludes the cost of non-prescribed (over-the-counter) drugs consumed in relation smoking attributable conditions. Our list only included the conditions identified through the highest cost or most frequency prescribed pharmaceuticals, and therefore will understate the costs due to omitted medications.

As an alternative approach, we calculated a high bound 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 smoking-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, 2018b). Assuming that the proportion of PBS listed pharmaceutical costs attributable to smoking matched the share of hospital separation costs in 2015/16, gives a high bound estimate of pharmaceutical costs of $638.9 million.

6.2.5 Smoking cessation pharmacotherapy

The use of smoking cessation medications greatly increases the rate of successful cessation (Eisenberg et al., 2008; Stead et al., 2012) and as a result, some smoking cessation products (i.e. nicotine replacement patches, varenicline and bupropion) are subsidised via the Pharmaceutical Benefits Scheme (PBS) or the Repatriation Pharmaceutical Benefits Scheme (RPBS). These benefits are available for a single course of treatment per year for the general population, with Aboriginal and Torres Strait Islander people eligible for two 12-week courses of nicotine replacement therapy (NRT) per year. The cost-estimation by Collins and Lapsley did not include the cost of 'over-the-counter' cessation products and only included bupropion as a subsidised cessation product (Collins and Lapsley, 2008). NRT was added to the PBS listing for Repatriation clients only in 2000, for Aboriginal and Torres Strait Islanders in 2008 and for the general population in 2011; varenicline was listed in 2008 (Drug utilisation sub-committee (DUSC), 2019).

The costs for pharmacotherapy prescribed via the PBS or the RPBS were obtained from the PBS website (Pharmaceutical Benefits Scheme, 2018b) with the relevant products (e.g. specific nicotine replacement therapies, varenicline, bupropion) identified from the Australian Statistics on Medicines resource (Pharmaceutical Benefits Scheme, 2016b). Bupropion was originally formulated as an antidepressant, but in Australia it is only approved as a smoking cessation aid. From PBS/RPBS data, the total cost of cessation medications, including bupropion was **$44.5 million** (Table 6.3).

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 script and when concessional patients reach their threshold, they make no co-payment. Co-payments for those covered by the 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 get a total co-payment value of **$10.1 million**.

Use of over-the-counter (OTC) NRT products in 2015/16 was estimated using unpublished data from the Centre for Behavioural Research in Cancer. There were 3,581,759 NRT sales, of which 793,946 were for patches, with PBS data showing that there were 171,522 (22 %) NRT transdermal patch prescriptions (Pharmaceutical Benefits Scheme, 2018b). The remaining 3,410,237 OTC sales were comprised of: 1,492,241 for gum; 798,403 for lozenges; 622,424 for patches; 373,482 for mist sprays; 110,034 for inhalators; and, 13,653 for oral strips. Excluding transdermal patches the reported value was $80.7 million. Of the $23.3 million cost of patches, we subtracted 22 per cent, representing the cost of prescription dispensed patches ($5.1 million) and added the remaining 78 per cent ($18.2 million), to total cost of OTC purchases of over **$98.9** million (Table 6.3). These data formed the central estimate.

Table 6.3: Nicotine replacement therapy and other cessation medications

Cost area	Central estimate ($)
PBS & RPBS pharmacotherapy [1]	44,479,266
PBS & RPBS co-payments	10,082,747
OTC Pharmacotherapy [2]	98,924,552
Total	**153,486,565**

[1] From PBS website: specific NRT transdermal patches, varenicline and bupropion:
[2] Unpublished data CBRC
OTC = over the counter: PBS = Pharmaceutical Benefits Scheme: RPBS = Repatriation Pharmaceutical Benefits Scheme

6.3 Long-term care costs

6.3.1 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 smoking-related health conditions. Notably, many older patients remain in hospital while waiting for access to residential age care: in 2015/16 it was estimated that this period was 11.3 days per 1000 patient days (Steering Committee for the Review of Government Service Provision, 2018b) [11]. These days in hospital are included with other hospital costs and are reported in Chapter 5. 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, 2017c).

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, 2017b)). 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 suggests that 53 per cent 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 smoking 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 smoking attributable cost to government of high level residential care was **$293.6 million** and the smoking attributable cost to government of other aged care services was **$126.6 million.**

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

6.3.2 Informal carers

In addition to the costs of formal care, a substantial amount of care is provided informally by family and friends. Deloitte Access Economics estimated that the total value of informal care in Australia (valued at replacement cost) was $60.3 billion in 2015, with 825,000 persons reporting that they were primary carers of someone impaired due to disability or ageing and a further 2,032,000 Australians reporting that they were a non-primary carer (Deloitte Access Economics, 2015).

Survey data reveal a significant difference in the number of disabled persons reporting that they needed support with at least one activity (a total of 303,808 reporting needing assistance from informal carers at least once a year, with 233,000 reporting informal assistance is needed at least once per week) (Australian Bureau of Statistics, 2017c) and the number of persons reporting that they are informal carers (2,857,000, (Deloitte Access Economics, 2015)).

There are no data that provide guidance on whether the estimate of informal care provision from those with impairments or from those reporting that they provide informal care is more likely to be accurate and so we used the former to derive our low bound and the latter to derive our high bound.

The following primary conditions were included in the unit record data in a disaggregated form [12] and were at least partially caused by smoking (Australian Bureau of Statistics, 2017c):

- Bowel/colorectal cancer;
- Other neoplasms;
- Diabetes type 2;
- Parkinson's disease (protective effect, thus reducing net care costs);
- Macular degeneration;
- Heart disease;
- Myocardial infarction (heart attack);
- Other heart diseases;
- Hypertension (high blood pressure);
- Stroke;
- Other diseases of the circulatory system;
- Emphysema;
- Asthma;
- Chronic Airflow Limitation (CAL);
- Stomach/duodenal ulcer;
- Arthritis and related disorders; and,
- Breathing difficulties/shortness of breath.

In each case the number of persons reporting that they received informal assistance for activities was adjusted to smoking attributable cases using the proportion of hospital separation costs for that condition attributable to smoking (see appendix Chapter 6.2).

There were 12,408 persons reporting that they needed informal assistance at least once per week due to a smoking attributable condition, or 5.3 per cent of the total persons reporting needing informal assistance at this frequency for any condition.

[12] A number of conditions caused by smoking, particularly cancers (including lung cancer) were not reported separately in the data but rather aggregated as other malignant neoplasms, and therefore could not be included in the calculation.

The cost to primary and secondary carers is likely to vary with the severity of the condition of the person being cared for, with increasing hours per week required for more severe conditions. Across severity levels, the average cost in 2015 was estimated at $70,362 per person per year (Deloitte Access Economics, 2015). Applying this average per person care cost estimate to the number requiring assistance for smoking attributable conditions gives an estimated total cost of informal care of $873.0 million.

As an alternative approach to estimation, we applied the share of persons needing assistance due to a smoking attributable condition (5.3 %) to Deloitte Access Economics' estimated total cost of informal care $60.3 billion (Deloitte Access Economics, 2015). This gives an estimated total cost of smoking attributable informal care of $3.2 billion. Taking the average of these two estimates gives a central value of **$2.0 billion**.

6.4 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 smoking is **$5.3 billion** in 2015/16 (Table 6.4). Even excluding the costs attributed to informal care, at just above $3.0 billion these costs are considerably greater than those for inpatient care. 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 smoking to society.

About 2.7 million Australians are informal carers, including 856,000 who are primary carers for a person with a health condition or disability (Australian Bureau of Statistics, 2016d). Many of the conditions caused by smoking are either chronic or are likely to involve extended treatment and recovery outside the hospital system, with assistance likely to include help from a partner/relative or significant other. We believe that this is the first attempt to qualify these costs in relation to smoking. From disease-specific assessments, it is clear that the contribution of informal carers makes a significant saving to the health budget. For example, in 2007/08 in the UK, the informal cost of caring for stoke patients has been estimated at 27 per cent of the economic cost of stroke or GBP 2.5 billion for 200,000 cases (GBP 125,000 per case [13]) (Saka et al., 2009). In Spain, the cost of informal care for those with COPD has been estimated at between EUR 24,549 and EUR 40,681[14] in 2008, with nearly half of those with COPD receiving some informal care (Peña-Longobardo et al., 2015).

[13] Approximately AU$251,232 in 2007 (Organisation for Economic Cooperation and Development, 2016b)
[14] Approximately AU$45,047 to AU$74,650 in 2008 (Organisation for Economic Cooperation and Development, 2016b)

Table 6.4: Summary of other health costs

Cost area	Central estimate ($)	Low bound ($)	High bound ($)
Ambulance	200,211,738		
Emergency Department	252,653,735		
Outpatient care	289,291,963		
Primary healthcare	1,458,142,411	765,665,566	1,458,142,411
Primary healthcare - GP Visits	*508,209,601*	*-*	*508,209,601*
Primary healthcare - Referred Medical services	*949,932,811*	*765,665,566*	*949,932,811*
Pharmaceuticals for smoking-related conditions	451,117,678	451,117,678	638,909,711
Smoking cessation aids [1]	153,486,565		
High-level residential care	293,560,781		
Other aged care services	126,576,403		
Informal carers	2,041,356,665	873,048,194	3,209,665,136
Total	**5,266,397,941**	**3,405,612,624**	**6,622,498,445**

Notes: Central estimates have been used to calculate totals where low or high bound costs are not available. [1] Prescribed plus over the counter.

Table 6.5 summarises all the healthcare related costs mentioned in Chapters 5 and 6 and the proportion of cost attributable to smoking. Overall, the total healthcare related expenditure during 2015/16 was $151.7 billion. Out of that, $6.7 billion was attributable to smoking-related conditions (4.4 per cent of the total). Figure 6.1 shows the percentage of costs in each part of the health care system attributable to smoking-related illness.

Table 6.5: Smoking attributable cost share of total expenditure for healthcare services in 2015/16.

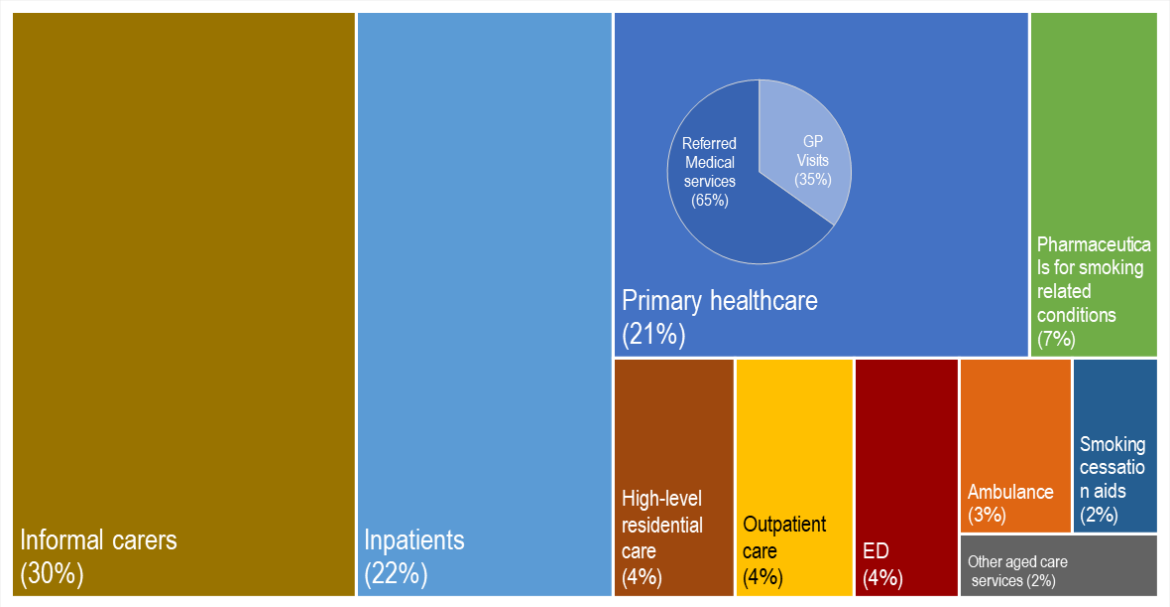
Item	Smoking Attributable (million $) [a]	Total Health Expenditure (million $)	Smoking Attributable Share %
Hospital Separations	1,520,793,772	28,348,000,000	5.4%
Ambulance and ED	452,865,473	8,441,532,753	5.4%
Outpatient care costs	289,291,963	5,392,479,067	5.4%
Primary healthcare [b]	1,458,142,411	29,460,000,000	4.9%
Medications (including PBS / RPBS cessation medications [c])	505,679,691	11,909,446,775	4.2%
Aged care (Including high level residential care) [b]	420,137,184	7,831,468,746	5.4%
Informal care	2,041,356,665	60,272,000,040	3.4%
Total healthcare related expenditure	**6,688,267,161**	**151,654,927,381**	**4.4%**

[a] Central costs estimates

[b] Total health expenditure only includes in scope costs (section 5.2.3 (80.6% of BEACH total) 5.3.1 (excluded dementia costs)

[c] Excludes over-the-counter smoking cessation aids - $98.9 million

Figure 6.1: Source of smoking attributable costs across the health sector including informal carers (% of total smoking attributable health sector costs)



6.5 Limitations

In calculating our central estimate for the number of excess general practice visits incurred by smokers, we followed a slightly modified version of the methods used previously (Collins and Lapsley, 2008). However, there is emerging evidence giving reason to question whether smokers are greater users of primary care services than non-smokers. A longitudinal study of nearly 14,000 Australian men, found that middle aged (35-55 years) smokers were less likely to have regular health check-ups (OR 0.7, 95% CI 0.5 – 0.8) but there were no significant differences in terms of visiting a GP in the last year than non-smokers (Schlichthorst et al., 2016). Similarly, data from the Australian Longitudinal Study on Women's Health reported that never smokers, former smokers and current smokers had a similar number of GP visits, as shown by Medicare Benefit Scheme data (Mishra et al., 2016). Therefore, our estimate of increased number and cost from GP visits by smokers may be incorrect. Hence, the low bound estimate of the other health care costs excluded 'unreferred' services (e.g. GPs). However, the Australian Longitudinal Study on Women's Health found that smokers filled a greater number of (and at great cost) PBS prescriptions than never smokers (Mishra et al., 2016), consistent with our approach and previously used methods in this area.

Assessments of the costs of social care in the UK (Reed, 2017) and Ireland (ICF International, 2016b) found no significant difference in the use of residential care facilities by smokers compared with non-smokers, with the speculation that this was due to premature mortality among smokers. In our main estimate we included an additional cost for smokers as previously done in Australian analyses, which may thus overestimate this cost (Collins and Lapsley, 2008; Whetton et al., 2013).

It is also important to recognise that increases or decreases in costs may be independent of the level of harm arising from smoking. In 2001-02 it was estimated that the PBS subsidy on medications for cardiovascular disease (CVD) was $1.29 billion, of which $126 million (9.77 %) was for smoking-related CVD (Hurley et al., 2004). In 2015-16, the cost of CVD subsides had increased to $1.45 billion (Australian

Institute of Health and Welfare, 2018a) less than the $1.85 billion that adjusting just for CPI would indicate (Australian Bureau of Statistics, 2016c). While this may indicate a decline in CVD, there has also been a reduction in the cost of some key medications (e.g. atorvastatin, rosuvastatin), which may also contribute to this change.

Inclusion of the costs incurred by informal carers is an important addition of the current study. Even though we were only able to report on a limited set of conditions and hence we are likely to have under-estimate the cost to informal carers across some of the important categories of smoking-related diseases. Further, little is known about the costs and experience of informal care giving amongst Aboriginal and Torres Strait Islander persons or in culturally and linguistically diverse groups in Australia (Girgis and Lambert, 2017).

Finally, we included patient co-payments for relevant prescription medications and AIHW data on primary health care includes any spending by households as well as the cost to government. Hospital separation costs are based on average cost of episodes in public hospitals (including any co-payments from individuals). However, if the cost per episode systematically differs between public and private hospitals, our estimates may under- or over-estimate the cost of hospital separations. Our estimates of emergency department and hospital outpatient costs which are based on data from public hospitals (IHPA 2018) and therefore will understate costs for these items. Across all forms of hospital spending, private hospitals account for 22 per cent of the national total, but we were unable to find data which identified outpatient or emergency department costs in private hospitals. As noted above, the cost estimate also does not include private contributions towards residential and other age care services, and therefore total costs will be understated.

CHAPTER 7: WORKPLACE – COSTS OF ABSENTEEISM & PRESENTEEISM

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7.1 Background

Smoking by Australian employees generates a range of costs, including the costs arising from reduced productivity. In 2004/05, workplace tobacco-related costs were estimated to comprise almost half (i.e., $5.7 billion) of all total tangible tobacco-related costs (i.e., $12.0 billion) largely due to the impact of premature tobacco attributable mortality (Collins and Lapsley, 2008). Tobacco-related costs arise from various sources including premature deaths, absence from work due to tobacco-related morbidity and injury, and reduced productivity while at work (also known as 'presenteeism'; this latter form of cost was not included in Collins and Lapsley (2008) due to data limitations).

Current smokers (i.e., daily and occasional smokers) are known to be at increased risk of workplace absenteeism compared to non-smokers (Weng et al., 2013). The costs of reduced productivity at work may outstrip those for absenteeism (Baker et al., 2017; Owen et al., 2018). Given the tighter restrictions on workplace smoking, which could result in some employees vacating their workplace in order to smoke, these costs could possibly have increased over time, overall (decreases in smoking prevalence notwithstanding). Estimates for costs associated with premature mortality and lost productivity including costs to Australian businesses are presented in Chapter 4 of this report. Estimates for other costs to Australian workplaces are presented below.

7.2 Method and results

To estimate the excess absenteeism and health-related presenteeism costs attributable to employees' tobacco smoking, secondary analyses of representative Australian data were undertaken. Data were sourced from the 2016 National Drug Strategy Household Survey (NDSHS) (Australian Institute of Health and Welfare, 2017d); a triennial survey examining awareness, attitudes, and self-reported behaviours concerning alcohol, tobacco, and other drugs. Only data for employed respondents (those who were self-employed or working for wages, salary, or in-kind payment) aged 14 years or older were included in the analyses.

In relation to absenteeism, Analysis of Variance (ANOVA) was first conducted to establish whether workers who were smokers[15] were more likely to be absent from work than non-smokers, One continuous measure of absenteeism was used which summed the total number of days absent due to injury or illness in the past three months (with a maximum possible 60 days absent) and then multiplied this by four to obtain a non-seasonally adjusted annual estimate.

An Analysis of Covariance (ANCOVA) was then conducted to determine mean absenteeism by smoking 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).

[15] Four categories of smoking status were recorded: Daily smoker, occasional smoker (less than daily), ex-smoker, never smoked.

Total absenteeism-related costs associated with each category of smoking status was then estimated. To accomplish this, the difference in mean number of annual days absent according to smoking status was calculated by subtracting the mean days absent of the never smoked group from the other smoking categories. This figure was then multiplied by $373.66 (one day's wage plus 20% employer on-costs, based on the average weekly income in 2015 (Australian Bureau of Statistics, 2016b)) to obtain a cost estimate of smoking-related absenteeism (i.e. following a replacement labour cost approach, rather than an economic output per day worked approach).

Calculations estimating the extent and cost of tobacco-related presenteeism in Australian workplaces were based on international data concerning the relationship between tobacco smoking and presenteeism (Baker et al., 2014), and previous estimates of any-cause Australian workforce presenteeism (Medibank, 2011). Secondary analyses of 2016 NDSHS data were also conducted to calculate the total number of employed current smokers (both daily and occasional).

7.2.1 Workers' smoking prevalence

A total of 11,792 (weighted N = 10,435,687) employed Australians aged 14 years or older provided tobacco smoking status information in the 2016 NDSHS. Of these, 12.5 per cent were daily smokers, 3.5 per cent were occasional smokers (smoked less than daily), 23.8 per cent were ex-smokers, and 60.2 per cent had never smoked (Table 7.1).

Table 7.1 Smoking status among employed Australians by age and gender (2016 NDSHS data [a])

Category	Daily smoker % (N)	Occasional smoker % (N)	Ex-smoker % (N)	Never smoked % (N)
All persons	12.5 (1,308,399)	3.5 (363,317)	23.8 (2,479,910)	60.2 (6,284,060)
Female	10.2 (491,756)	2.8 (134,438)	23.9 (1,144,869)	63.1 (3,029,087)
Male	14.5 (816,644)	4.1 (228,879)	23.7 (1,335,042)	57.8 (3,254,973)
14-19 years	5.7 (18,970)	1.9 (6,235)	3.0 (10,062)	89.4 (296,508)
20-29 years	15.2 (306,006)	5.1 (103,298)	8.3 (166,916)	71.4 (1,436,838)
30-39 years	11.7 (294,225)	4.7 (117,902)	23.3 (587,431)	60.3 (1,516,337)
40-49 years	14.4 (353,051)	2.8 (69,211)	26.9 (658,998)	55.8 (1,364,162)
50-59 years	11.7 (249,832)	2.5 (54,510)	33.8 (725,681)	52.0 (1,113,812)
60+ years	8.8 (86,315)	1.2 (12,161)	33.6 (330,823)	56.4 (556,404)

[a] Australian Institute of Health and Welfare, 2017. National Drug Strategy Household Survey (NDSHS) 2016, Drug Statistics Series. Canberra, Government of Australia

7.2.2 Workplace absenteeism

ANOVA indicated smoking status was significantly associated with workplace absenteeism ($F [3, 10491] = 8.64, <.001$).

Results of the ANCOVA indicated that controlling for age, gender, marital status, socio-economic status, and occupation, smoking status remained significantly associated with absenteeism ($F [3, 7015] = 7.67, <.001$). As shown in Table 7.2, daily smokers, occasional smokers, and ex-smokers reported missing an extra 11,309,323 days from work per year compared to workers who had never smoked. These

differences ranged from 1.707 to 3.726 additional days per year: a recent meta-analysis reported that the excess for current smoker was 2.74 days per year (Weng et al., 2013). Overall, this equated to a financial cost of **$4.2 billion** dollars in 2015/16.

Table 7.2 Excess workplace absenteeism of smokers and ex-smokers compared to non-smokers (2016 NDSHS data [a]) and associated costs (2015 ABS data [b])*

		Annual Illness or Injury Absence			
Smoking status	**Estimated Population**	**Mean Days Absent (95% CI)**	**Difference [c] (95% CI)**	**Excess Days Absent [d] (95% CI)**	**Cost $ [e] (95% CI)**
Never smoked	6,284,060	6.837 (6.058 – 7.616)	-	-	-
Ex-smoker	2,479,910	9.181 (8.054 – 10.309)	2.344 (1.996 – 2.693)	5,813,450 (4,949,495 – 6,677,403)	2,172,253,600 (1,849,428,222 – 2,495,078,321)
Occasional smoker	363,317	8.544 (5.519 – 11.568)	1.707 (-0.538 – 3.952)	620,172 (0 – 1,435,981) [f]	231,733,314 (0 – 536,568,790) [f]
Daily smoker	1,308,399	10.563 (8.997 – 12.130)	3.726 (2.939 – 4.514)	4,875,702 (3,845,518 – 5,905,883)	1,821,854,724 (1,436,916,401 – 2,206,792,417)
			TOTAL	**11,309,323 (8,795,013 – 14,019,268)**	**4,225,841,638 (3,286,344,623 – 5,238,439,528)**

[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] Mean days absent due to illness/injury for ex, occasional and daily smokers minus mean days absent for never smoked.
[d] Difference in mean absence multiplied by estimated population.
[e] Excess absence multiplied by $373.66 (2015 average daily wage plus 20% employer on-costs).
[f] To simplify interpretation of results, negative difference values (including 95% confidence intervals) were rounded to 0.
*Calculations based on estimated absenteeism means adjusted for age, gender, marital status, socio-economic status, and occupation.

7.2.3 Workplace presenteeism

In addition to absenteeism, further tobacco-related costs can be incurred through health-related presenteeism. Productivity costs resulting from presenteeism can occur when employees attend work while unwell or impaired and perform in a sub-optimal manner, resulting in lower quality or quantity of work. A recent large study examining US, European, and Chinese employees found that current smokers reported an average of 19.3 per cent more presenteeism than never-smokers (Baker et al., 2017).

In Australia, previous research has estimated that, on average, 6.5 working days of productivity are lost per employee annually as a result of presenteeism due to any cause (Medibank, 2011). Adjusting these data to exclude current smokers results in a presenteeism rate of 6.3 days for non-smokers. National prevalence data (Australian Institute of Health and Welfare, 2017d) indicate that 1,671,716 employed Australians were current smokers (daily and occasional smokers) in 2016. Based on these data, it is estimated that current smokers accounted for over 2 million extra days presenteeism each year at a direct cost of nearly **$759.5 million** (Table 7.3).

Table 7.3 Excess workplace presenteeism of smokers (2016 NDSHS data [a]) compared to Australian working population norm for presenteeism (Medibank, 2011 data [b]) and associated costs

Smoking status	Estimated Population (95% CI)	Annual presenteeism	Excess days per employee	Total excess (95% CI)	Cost $ (95% CI) [d]
Reference population: never & ex-smokers		6.3 days	-	-	-
Daily / occasional smoker	1,671,716 (1,579,294 – 1,764,139)	7.5 days [c]	1.2 days	2,032,639 (1,920,264 – 2,145,017)	759,516,070 (717,525,687 – 801,506,907)

[a] Australian Institute of Health and Welfare, 2017. National Drug Strategy Household Survey (NDSHS) 2016, Drug Statistics Series. Canberra, Government of Australia.
[b] Medibank, 2011. Sick at Work. The cost of presenteeism to your business and the economy. Melbourne, Medibank.
[c] 19.3 per cent excess presenteeism of current smokers compared to never smokers, (Baker et al., 2017).
[d] Excess presenteeism days multiplied by $373.66 (2015 average daily wage plus 20% employer on-costs), again essentially using a replacement cost rather than lost economic output measure of cost.

7.2.4 Compensable occupational illness and injury costs

Tobacco smoking is also likely to contribute to additional compensable workplace absenteeism costs that may not be detected by comparing differences in absenteeism rates according to smoking status. Secondhand smoke increases risk of respiratory illness (Jayes et al., 2016) and cardiovascular disease (Fischer and Kraemer, 2015) in non-smokers. Despite the introduction of smoke-free workplace legislation, some Australian industry groups such as construction (Driscoll et al., 2016), manufacturing (Darcey et al., 2016) and hospitality (Wakefield et al., 2005) remain high-risk occupational groups for workplace exposure to environmental tobacco smoke, and may result in compensable occupational illnesses. However, lack of data prevents the reliable quantification of tobacco attributable costs due to workplace environmental smoke exposure across the Australian workforce.

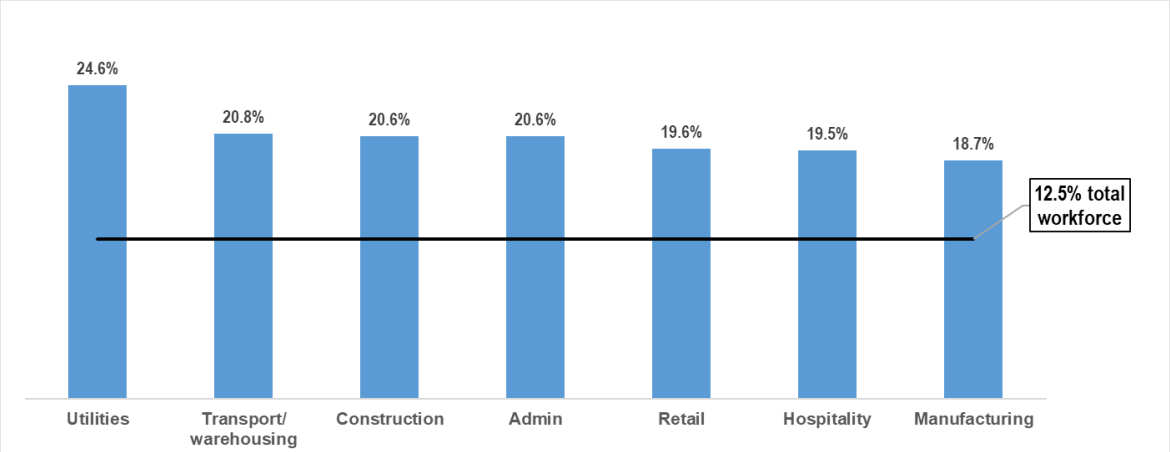
Similarly, tobacco smoking is likely to contribute to workplace costs associated with compensable occupational injury. There is substantial evidence that tobacco smoking delays wound healing and is associated with longer hospital stays (Avishai et al., 2017; Rodriguez-Merchan, 2018) which in turn is likely to increase compensation costs and delay effective return to work. Tobacco smoking may also have a more direct impact on workplace injury costs. An early review of the evidence identified smokers as being 1.4 – 2.5 times more likely to be injured at work compared to non-smokers (Sacks and Nelson, 1994). The authors concluded that the association between smoking and workplace injury identified in that review may have been due to: 1) direct toxicity; 2) distractibility; 3) medical conditions associated with smoking, and / or 4) confounding factors such as increased prevalence of alcohol or other drug use among smokers.

A more recent study found that in comparison to ex- and non-smokers, smokers were significantly more likely to report activity impairment in daily activities due to health problems (Baker et al., 2017).

The costs associated with all these forms of additional illness, injury and disability are likely to be substantial. Despite such evidence, lack of data prevents the reliable quantification of tobacco attributable cost to compensable occupational injury in Australian workplaces.

It is also important to note that tobacco-related workplace costs are unlikely to be evenly distributed across Australian workplaces. Previous Australian research indicates that smoking prevalence varies substantially across occupational groups (Smith, 2008). Secondary analyses of 2016 NDSHS data confirm substantial differences in daily smoking prevalence across Australian industries (Figure 7.1). For example, the prevalence of daily smoking was significantly higher among workers in utilities, transport and warehousing, construction, administration, retail, hospitality, and manufacturing industries compared to the total workforce (12.5 %).

Figure 7.1. Prevalence of daily smoking by industries with significantly higher prevalence of daily smoking compared to the total workforce (2016 NDSHS data [a])



[a] Australian Institute of Health and Welfare, 2017. National Drug Strategy Household Survey (NDSHS) 2016, Drug Statistics Series. Canberra, Government of Australia.

7.3 Conclusions

12.5% total workforce

A summary of the estimated excess absenteeism and presenteeism-related [illegible]able to employees' tobacco smoking is presented in Table 7.4. The total cost was estimated to be **$5.0 billion** per annum with a low and high bound range, based on 95 per cent confidence intervals presented in Tables 7.2 and 7.3, of $4.0 billion to $6.0 billion per annum.

Table 7.4 Summary of tobacco-related workplace costs

Cost area	Central estimate $	Low bound [a] $	High bound [a] $
Absenteeism	4,225,841,638	3,286,344,623	5,238,439,528
Presenteeism	759,516,070	717,525,687	801,506,907
Total	**4,985,357,707**	**4,003,870,311**	**6,039,946,435**

[a] based on 95% confidence intervals: may not sum due to rounding

7.4 Limitations

The working age population used in calculating both the cost of smoking attributable absenteeism (due to illness or injury) and smoking attributable presenteeism was based on those who answered the absenteeism-related questions in the NDSHS 2016 (Australian Institute of Health and Welfare, 2017d). As not all of the NDSHS respondents of working age answered these questions, the estimated population of smokers in the workforce, and therefore the smoking-related costs, are likely to be underestimated. Moreover, these estimates do not include the extent or cost of short-term absenteeism that occurs when employees take smoking breaks, on the assumption that taking these breaks will reduce overall

productivity. A recent analysis from Ireland estimated eight minutes per break, and on that basis, breaks for smoking contributed about 60 per cent on top of the cost of absenteeism. That is, the cost of breaks was EUR 136 million compared with EUR 224 million for absenteeism (ICF International, 2016a).

Data used to estimate excess rates of tobacco-related presenteeism were based on international research that may not accurately reflect the extent of smokers' presenteeism in Australian workplaces. It should also be noted that the national daily income figures (average day's wage plus on-costs) used to calculate both absenteeism and presenteeism cost estimates may represent an overestimation of presenteeism, depending on the amount and quality of the work undertaken on any given presenteeism day. Data used to estimate absenteeism costs were based on the assumption that people worked a 5-day working week, for 48 weeks per year (allowing for 4 weeks annual leave). This may not be a true reflection of employees' actual work schedule (part time, overtime, longer rosters) and may limit assumptions about annual absenteeism rates.

CHAPTER 8: OTHER TANGIBLE COSTS

Steve Whetton & Robert J. Tait

8.1 Expenditure on tobacco by dependent smokers

The costs of tobacco consumed by smokers is sometimes included in social cost estimated: in 2004/05 this was costed at $3.6 billion as the total purchase costs minus taxes (Collins and Lapsley, 2008). Whether or not expenditure should be included in a social cost study depends on two criteria - whether or not the social cost study is including costs borne by the substance user themselves (i.e. internalities) and whether the expenditure was fully voluntary and well informed.

This study does include those costs borne by smokers that were not fully taken into account in making consumption decisions. Any expenditure by ***dependent*** smokers, net of any taxation revenue collected from that expenditure (which acts a transfer from smokers to the rest of society rather than a net cost) therefore represents a social cost in the framework of this report.

The total expenditure on cigarettes and tobacco products was obtained from the data on household final consumption expenditure reported in the *Australian National Accounts* (Australian Bureau of Statistics, 2019) with total expenditure being $17.0 billion including GST (and $15.5 billion excluding GST: GST being 1/11th of the GST inclusive expenditure). As tax revenue on tobacco is effectively a transfer between smokers and the rest of society, it is not included in social cost estimates (Collins and Lapsley, 2008; Single et al., 2003).The total revenue accrued from tobacco excise was $9.8 billion (Morrison and Cormann, 2017). Thus, the expenditure on tobacco net of excise and GST was $5.6 billion (also see Chapter 10.1).

Analysis of the 2016 NDSHS unit record file suggests, based on self-reported consumption of cigarettes in the week prior to the survey, that around 98 per cent of cigarette consumption is by daily smokers, with a further 1.4 per cent of cigarettes consumed by those smoking less than daily but at least weekly, and 0.4 per cent by those who smoke less than weekly (Australian Institute of Health and Welfare, 2017e). Taking the approach adopted in the rest of this report of treating daily smokers as a reasonable proxy for dependent smokers, this suggests that the social cost arising from expenditure by dependent smokers was **$5.5 billion**.

8.2 Smoking Attributable Fires

8.2.1 Background

As well as the harms caused by exposure to tobacco smoke, smoking also leads to harm through the role of discarded smokers' materials and accidental access to lighters or matches by children, as an ignition source for house fires, bushfires and other fires. Our estimate attempted to quantify the proportion of fires attributable to tobacco use.

We considered several possible sources of data on the cause of fires, each of which has advantages and disadvantages. English et al. (1995) produced estimates of the proportion of fire injuries deaths and hospital separations (excluding scalds) that could be attributed to smoking. The fractions derived by English et al (1995) were used in the mortality and hospital separation calculations of Collins and Lapsley (2008). This estimate was the result of detailed analysis of case report data, however the estimates are now dated.

For the costs of fires through lost property and the use of fire service resources, Collins and Lapsley (2008) used unpublished data from the Operations and Risk Planning Unit of the Queensland Fire and Rescue Service. Other agencies responsible for fire and rescue services in Australian States and Territories from time to time report data on the cause of fires based on the assessment of the attending personnel, however these are not always available contemporaneously and may lack the degree of confidence that can be derived from case controlled studies. Importantly, any data on the cause of fires needs to be disaggregated by type of fire, as cigarettes may have a more significant role in causing house fires and bushfires than for other fire types.

Several social and legislative changes also needed to be considered in revising the cost of fires attributable to smoking. The data need to reflect the combined impact of lower smoking prevalence and lower propensity to smoke inside the house (Australian Institute of Health and Welfare, 2014a, b), together with the introduction of reduced-ignition propensity cigarettes in 2010, lowering the risk of fires even where cigarettes are not fully extinguished (Bonander et al., 2015; Saar, 2018). Thus, the proportion of fires and fire injuries attributable to smoking may be expected to be lower than was the case in either English et al. (1995) or in the analysis of Queensland Fire and Rescue data undertaken by Collins and Lapsley (2008).

Our approach was to use the costs of fire service time and other resources as reported in *Review of Government Service Provision* (Steering Committee for the Review of Government Service Provision, 2017a). We also sought further details directly from individual State and Territory fire services.

It is important to note that fires caused by smoking have costs, including on the health system, workforce productivity and lost labour to the household that were included in other sections of this report. It is estimated that these 'other costs' may represent more than 40 per cent of total costs arising from fires (Collins and Lapsely, 2014). To avoid 'double counting', we clearly delineated the unique costs of fires from the harms and costs that are including in other sections of the report.

8.2.2 Method

From the *Review of Government Services* (2017a) we noted 1,247 structural fires (i.e. fires within residential or commercial buildings) where the source of ignition was reported as the misuse of heat, including 474 from abandoned, discarded materials, including cigarettes. From insurance claims, the average cost of domestic fires was $57,858 and commercial fires $92,237 in 2015/16 (Steering Committee for the Review of Government Service Provision, 2017a). However, the source of ignition was not reported separately for commercial and domestic fires. The *Review* reported a further 40,960 landscape fires but costs and sources of ignition were again not detailed (Steering Committee for the Review of Government Service Provision, 2017a).

Data were therefore requested from individual States and Territories on fires attributable to smoking cigarettes. Reports were received from New South Wales (personal communication Fire and Rescue Service 2018); Queensland (personal communication Queensland Fire and Emergency Services 2018); South Australia, which included one fatality and six injuries (personal communication South Australian Metropolitan Fire Service 2018); Western Australia (personal communication Department of Fire & Emergency Services 2018). In metropolitan Victoria there were 1,814 fires (personal communication Victorian Metropolitan Fire Brigade 2018). Victorian figures also included damage estimates for the

relevant fires by fire officers, with a total cost of $2.1 million. We used this figure in creating the low bound estimate for each jurisdiction, with the central estimate for each reduced by the same proportion as the Victorian estimate. We were unable to obtain data from Tasmania, the Northern Territory and the Australian Capital Territory. The NSW data, although provided as fires due to cigarettes as an ignition source, required coding from variables on 'property / location' and 'incident type' to identify relevant structural fires. Data from WA reported only on residential fires and landscape fires.

Estimating the cost of bushfires remains problematic, even for specific events. The estimates for the cost of the Ash Wednesday bushfire range from $556 million to $1,872 million (Ladds et al., 2017). Costs on a per hectare basis also vary markedly depending on the nature of the damage and any loss of life. However, where the major costs are environmental damage and lost natural resources, net costs of $1,831 per hectare (in 2009 dollars) have been calculated (Stephenson et al., 2013). Nevertheless, we were unable to identify an average cost of tackling bushfires and any resultant damage.

The cost of structural fires was estimated using the average cost of domestic ($57,858) and commercial ($92,237) fires (Steering Committee for the Review of Government Service Provision, 2017a): where structural fires were not disaggregated, the domestic value was used. This provided our central estimate. In the case of Victoria, we used their reported damage estimate as the low range. For the States and Territories where we were unable to obtain information on the number of fires caused by cigarettes, we projected the number of fires based on the pro-rata number of daily smokers in each jurisdiction and the number of fires per daily smoker in Victoria (Table 8.1). The same approach was used in projecting the number of commercial fires in WA.

Table 8.1: Number of daily smokers and projected all smoking-related, domestic, commercial and landscape fires

State / Territory	Population aged ≥ 14 Dec 2015 [a]	% daily smokers [b]	No. daily smokers	Projected all fires	Projected domestic	Projected commercial	Projected landscape
ACT	317,352	9.5	30,148	96.3	5.6	2.7	16.8
NSW	6,191,956	11.5	712,075	(Table 8.2)	(Table 8.2)	(Table 8.2)	(Table 8.2)
NT	190,559	17.2	32,776	104.7	6.1	2.9	18.3
QLD	3,836,469	14.5	556,288	(Table 8.2)	(Table 8.2)	(Table 8.2)	(Table 8.2)
SA	1,399,994	10.8	151,199	(Table 8.2)	(Table 8.2)	(Table 8.2)	(Table 8.2)
TAS	422,497	16.0	67,600	215.9	12.5	6.1	37.8
VIC	4,855,319	11.7	568,072	(Table 8.2)	(Table 8.2)	(Table 8.2)	(Table 8.2)
WA	2,092,841	11.5	240,676	(Table 8.2)	(Table 8.2)	21.6	(Table 8.2)

[a] (Australian Bureau of Statistics, 2016a): [b] (Australian Institute of Health and Welfare, 2017a)

8.2.3 Results

Structural fire costs

Table 8.2 shows the number of fires in each jurisdiction with a total of at least 4,557 fires caused by cigarettes of which over 473 were structural fires and 1,800 were landscape fires, leaving about 2,284 unclassified. These comprised items such as outside rubbish fires and other outside property. The South Australian data did not divide structural fires into commercial and domestic: we used the average cost of domestic fires for all the South Australian fires. The overall central estimate was **$32.0 million** with the low bound estimate being $6.1 million. Importantly, over 2,200 smoking caused fires remained unclassified and over 4,084 did not have a cost allocated to them in the data.

Table 8.2: Numbers of smoking-related fires and estimated cost of domestic and commercial fires in 2015/16

State / Territory	All smoking-related fires	Landscape fires	Building content ± structure	Domestic fires	Commercial & other property fires	Estimated cost $(000,000)
Australian Capital Territory	96.3	16.9	-	5.6	2.7	0.6
New South Wales	1,089	382	-	94	28	8.0
Northern Territory	104.7	18.3	-	6.1	2.9	0.6
Queensland	332	253	-	58	21	5.3
South Australia	154	51	30	-	-	1.7
Tasmania	215.9	37.8	-	12.5	6.1	1.3
Victoria	1,814	318	-	105	51	10.8
Western Australia	752	723	-	29	21.6	3.7
Total	**4,557.9**	**1,800**	**30**	**310.2**	**133.3**	**32.0**

Sources: personal communication, fire services in each State and Territory

Salaries and structural costs

In 2015/16 the total cost of fire services (e.g. salaries, capital costs) was $4.1 billion (Steering Committee for the Review of Government Service Provision, 2017a, Table 9A.28). In order to attribute a proportion of these costs to cigarette caused fires, we used the same proportion of costs as 'smoking-related' to 'all fires and other emergency and incident responses' (4,557.9 / 382,440 = 0.0119 (Steering Committee for the Review of Government Service Provision, 2017a, Table 9A.13). The salaries and other costs attributed to smoking caused fires was thus **$48.8 million**.

8.2.4 Conclusions

The estimation of the cost of fires where cigarettes were deemed to be the source of ignition was derived from both raw data provided by the relevant emergency services and, where this was unavailable, projections based on the number of daily smokers. However, we were unable to estimate the cost of landscape fires. In addition, with respect to the use of resources by fire services (people and equipment), the estimate was based on a crude approximation that did not include time when staff was engaged in activities not related to fires or responding to other non-fire incidents. The total cost was **$80.8 million** (Table 8.3)

Table 8.3: Summary of the cost of fires attributed to smoking

Cost area	Central estimate $	Low bound $
Property	31,978,483	6,107,615
Salaries / resources	48,789,910	48,789,910
Total	**80,768,393**	**54,897,525**

Despite the limited data available and the fact that the number of fires in some States and Territories had to be projected, our total number of structural fires (473.5) attributed to smoking is close to the number reported by *Review of Government Services* (2017a) which estimated that 474 structural fires resulted from abandoned, discarded materials, including cigarettes. However, the number of fires is markedly lower than some previous estimates. Thus, in 2007-08, the equivalent figure was 1,530 structural fires from discarded materials, and 1,283 in 2010-11 when reduced ignition propensity cigarettes were

introduced (Steering Committee for the Review of Government Service Provision, 2015). In the Northern Territory there were estimated to have been 467 vegetation, 19.3 building and a total of 553 fires related to tobacco use in 2005/06 (Whetton et al., 2013) with the comparable figures for our data being 18.3, 9.0 and 104.7. Given the decline in the prevalence of smoking in the Northern Territory, with daily smoking falling from 25.3 per cent in 2007 to 17.2 per cent in 2016 (Australian Institute of Health and Welfare, 2017a), and the introduction of reduced ignition propensity cigarettes, some reduction might be expected, both in the NT and across Australia.

8.2.5 Limitations

The lack of costing information with respect to landscape fires remains a significant limitation, with a single bushfire ("Black Saturday") in Victoria resulting in costs estimated at $4 billion (Victorian Bushfires Royal Commission, 2009). In addition to lost lives and domestic property, fires also cause clear economic losses to community infrastructure, farm equipment, livestock and crops. Additional costs arise from environmental damage (flora and fauna) and loss of ecosystem resources (Australian Institute of Criminology, 2009), none of which was included in our estimate. The potential for a single catastrophic bushfire event to skew the cost data means that if landscape fires are included in a future estimate, an average over several years should be used to obtain a realistic costing.

The cost estimate for damage provided by Victoria included all smoking-related fires, not just structural fires. In using this in our low bound estimate for each jurisdiction, we capture some of the cost of the unclassified fires. It is important to note that this figure does not include salaries or resources used by fire services in attending fires. We therefore added our estimate for salaries to this cost.

8.3 Litter

8.3.1 Background

Litter from discarded cigarette butts and packaging imposes a cost on the general community, with cigarette butts the single most collected item in litter clean-up campaigns (Clean-up Australia, 2016; Eriksen et al., 2015). Cigarette butts (filters) are generally not bio-gradable and contain toxic chemicals causing contamination, especially in aquatic environments (Eriksen et al., 2015; Slaughter et al., 2011). There has been little research on the cost of removing this litter, and it is therefore often missing from social cost estimates (Collins and Lapsley, 2008). However, one Australian report estimated that in Victoria alone, cigarette related litter removal cost $25.7 million in 2015/16 (Creating Preferred Futures, 2018). A report from the UK estimated that the national cost of smoking-related litter was GBP 342 million in 2010 (Nash and Featherstone, 2010) and for Wales, the cost of smoking-related litter was GBP 25.8 million in 2012 (Grant, 2013). To recoup some of the cost of smoking related litter, in the USA, San Francisco has instigated a USD 0.20 litter clean-up fee that is added to the price of each pack of cigarettes sold (Eriksen et al., 2015).

8.3.2 Method and results

The only previous Australian study we identified on the costs of clearing litter, estimated the smoking-related costs just for Victoria (Creating Preferred Futures, 2018) and was based on an estimated total cost of all types of litter removal across Australia of $1 billion per year (Keep Queensland Beautiful, 2018), although the derivation of that figure was unclear. Of this total, 10 per cent of the cost was assigned to smoking-related litter, with cigarette butts alone constituting 8.6 per cent of items collected (Clean-up Australia, 2016) with packs, foils and cellophane wraps on top of that figure. On that basis, we estimate

that the total cost to Australia would be $100 million in 2015/16, which is 10 per cent of the total cost of litter removal. We used this as our upper estimate (Table 8.4).

Alternatively, the cost can be estimated from individual Australian jurisdictions. Street sweeping and litter removal cost $92 million for Victoria in 2015/16 (Sustainability Victoria, 2017) and for New South Wales the estimate was $162 million (Hunter Councils Environment Division, 2016). These two States represent 57.2 per cent of the Australian population aged over 14 years (Australian Bureau of Statistics, 2016a). In NSW, the prevalence of daily smoking in this age-group was 11.5 per cent and 11.7 per cent in Victoria (Australian Institute of Health and Welfare, 2017a) which gives a total of 1,280,147 daily smokers. The cost of smoking-related litter collection on a per smoker basis in these States was thus $19.84 per daily smoker, assuming 10 per cent of litter is smoking-related (Clean-up Australia, 2016). If this cost was applied to the remaining daily smokers in Australia (1,075,640) the total cost of smoking-related littering would be $46.6 million, which gives our low range estimate. The mean of the upper and low bound estimates (**$73.3 million**) is used as the central estimate.

Table 8.4 Litter costs

Cost area	Central estimate $	Low bound $	High bound $
Litter	73,322,292	46,644,584	100,000,000

8.3.3 Conclusions

The most recent analysis of national costs by Collins and Lapsley (2008) was unable to quantify the costs of cigarette related littering. However, more recently there have been estimates conducted both locally and internationally (Creating Preferred Futures, 2018; Grant, 2013; Nash and Featherstone, 2010). These have allocated substantial costs to litter removal, with the cost in Victoria alone thought to be over $25 million. On a pro-rata basis, our estimate for the entire of Australia is more conservative at $73 million, but this still represents a considerable impost on the general community.

8.3.4 Limitations

In addressing the cost of litter, the 10 per cent estimate was based on the number of items rather than the cost of collection and appropriate disposal, which would be a more appropriate basis for estimating the cost to the community. In addition, litter may have impacts on business (reduction in sales), environmental contamination (ICF International, 2016b) and loss of amenity to the public, which were not included in the total.

8.4 Conclusions

The central estimate together with low and high range for these additional tangible costs are shown in table 8.5. The cost of tobacco purchases by daily / dependent smokers makes up substantial proportion of the overall tangible costs of smoking, with this item representing 36 per cent of all tangible costs.

Table 8.5: Other tangible costs of smoking

Cost area	Central estimate $	Low bound $	High bound $
Tobacco purchases [a]	5,547,172,745	5,547,172,745	5,547,172,745
Fires	80,768,393	54,897,525	80,768,393
Litter	73,322,292	46,644,584	100,000,000
Total	**5,701,263,430**	**5,648,714,854**	**5,727,941,138**

[a] Dependent smokers only, excluding taxes

Acknowledgements

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CHAPTER 9: INTANGIBLE COSTS OF SMOKING ATTRIBUTABLE ILL-HEALTH

Steve Whetton

9.1 Background

In addition to the tangible costs, many of the health problems attributable to smoking also reduce the quality of life of those experiencing them.

Quality of life impacts due to ill-health are typically quantified through one of two measures of the number of health adjusted years of life lost to a condition, either a Disability Adjusted Life Year (DALY) or a Quality Adjusted Life Year (QALY). DALYs measure healthy years of life lost due to a disability (e.g. a year of life lived with perfect health has a DALY of 0, one with an impairment that reduces the quality of life by 60% has a DALY of 0.6) whereas QALYs measure the quality adjusted life years lived (so a year of life lived with perfect health has a QALY of 1, and one lived with an impairment that reduces the quality of life by 60% has a QALY of 0.4). In this sense the two measures are simply inverses of one-another. However differences in the ways in which the values for health states are elicited, the way the health state is assumed to change over time, and the ways in which underlying expected health without the condition are treated, means that although they are each seeking to assess the same underlying concept, they are likely to arrive at somewhat different estimates of the impact on quality of life. DALYs are generally preferred for burden of disease studies (and, for example, are used in the WHO's Global Burden of Disease studies). For this reason, DALY estimates have been preferred in this study to QALY estimates.

Where a DALY is lost due to premature mortality, this is often referred to as a year of life lost (YLL) and where the lost fraction of a DALY arises due to ill-health or injury this is often referred to as a year of life lost due to disability (YLD).

9.2 Method

Valuing DALYs is not without controversy (Baker et al., 2010; Dolan, 2010; Donaldson et al., 2011; Miller and Hendrie, 2011). The most straightforward approach (used, for example, in Moore (2007) and Nicosia et al., (2009) is to assume the value of a DALY equals that of a statistical life year. Values of a statistical life year (VoSLY) are derived from the value of a statistical life 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 for those from whose behaviours or survey responses the value of a statistical life has been derived (typically assumed to be 40 years, Abelson (2008)), using the following formula:

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

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 per cent per annum

r = the discount rate used, in this case seven per cent 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.

The limitation of this simple approach is that research has shown that the value of a life year is contextual, e.g. the value an individual places on avoiding a quality of life impact can depend heavily on factors such as age, current health state, expected years of life remaining, ability to pay, and individual views on optimal distribution of resources through the life cycle (Baker et al., 2010; Dolan, 2010; Donaldson et al., 2011). The prospective expressed willingness to accept less years of life in exchange for avoiding various health conditions or impairments also often appears too high given the degree of adaption observed in individuals with those forms of impairment (Dolan, 2010).

For this reason, it is often maintained that accurate estimates of DALYs can only be obtained through specific studies of the preferences of the population of interest. However, such studies are typically very time intensive and require substantial resources to implement. As such they are ill-suited for public policy analysis. There is also the concern that in adopting 'bespoke' values for a DALY, the difference in valuation may be driven by sampling error in the study rather than any difference in the underlying 'true' value, as well as creating an inconsistency between the ways in which averted deaths are valued compared to averted years of healthy life lost to disability. Thus, a value of a statistical life year estimate has been used in this study to value lost DALYs.

The Abelson estimate of the value of a statistical life was $3-4 million in 2007 values and needed to be converted to 2015/16 vales for this analysis. The rate at which a value of statistical life 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 value of a statistical life for a given increase in per capita incomes. For example, an income elasticity of 0.5 implies that for a 1 percent increase in per capita income the value of a statistical life would increase by 0.5 per cent. 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 Department of Transportation, 2015) in adopting a relatively conservative assumption of an income elasticity of 1[16], 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 value of a statistical life of $4.6 million.

Internationally, much higher values are often used reflecting the findings of studies into the value of a statistical life [17]. The US Department of Transport used a value of a statistical life of US$9.1 million in 2013 values (US Department of Transportation, 2015). This was derived by averaging 15 hedonic wage studies (e.g. studies which estimate the wage premium demand by workers for more dangerous occupations and use the difference in annual mortality rates between industries to calculate the implicit value placed on a premature death). The US Environment Protection Authority also adopts a similar

[16] 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).

[17] 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).

approach, using a similar but slightly different value derived from a slightly different set of studies. Converting the US Department of Transport VoSL estimate to Australian dollars using Purchasing Power Parity exchange rates (Organisation for Economic Cooperation and Development, 2016a), and then to 2015/16 values using the growth in per capita current prices GDP (Australian Bureau of Statistics, 2018b) from 2012/13 to 2015/16 gives a value of a statistical life of $13.6 million. This value is used as our high bound estimates.

Converting Abelson's value of a statistical life estimate (Abelson, 2008) to 2015/16 values using the growth in nominal GDP per capita, and then converting the value of a statistical life to a value of a statistical life year, gives a value per DALY lost, for 2015/16 of $286,553. Converting our upper bound estimate of the value of a statistical life, the US Department of Transport (US Department of Transportation, 2015) estimate converted to 2015/16 Australian values, to the value of a statistical life year gives an upper bound estimate of $841,393.

As a lower bound for the value per DALY lost we have used the implicit threshold value per DALY used for PBS approval, of $45,000 in 2014/15 values as the low bound: this latter value is implied rather than explicitly stated (Community Affairs References Committee, 2015; Harris et al., 2008).

The number of years of life lost due to disability was sourced from the Global Burden of Disease Study 2017 (Institute for Health Metrics and Evaluation, 2019). Data were extracted by condition and gender. Conditions which were partially caused or prevented by smoking were then identified within the data. Not all conditions identified as at least partially caused or prevented by smoking were individually identifiable in the GBD data, largely due to aggregation issues (for example, YLD data were only available for leukaemia as a whole, whereas the current evidence only indicates a causative role for smoking in acute myeloid leukaemia). The following conditions were **excluded** from the YLD calculation due to data unavailability:

- Cancer of nasal cavity;
- Endometrial cancer (protective);
- Acute myeloid Leukaemia;
- Parkinson's disease (protective);
- Cataract;
- Macular degeneration;
- Atherosclerosis;
- Aortic aneurysm;
- Peptic ulcer disease;
- Erectile dysfunction;
- Reduced fertility in women;
- Ectopic pregnancy;
- Miscarriage;
- Hypertension in pregnancy (protective);
- Premature rupture of membranes;
- Placenta previa and other antepartum haemorrhage;
- Orofacial clefts (secondhand smoke);
- Non-Hip Fracture; and,
- Hip Fracture. [18]

[18] Not all conditions listed in the Global Burden of Disease study had corresponding DALYs in the compare tool

Twenty-nine conditions were included in the calculation of YLD lost due to smoking attributable conditions. The proportion of YLD attributable to smoking was assumed to equal the share of hospital separation costs attributable to smoking for each condition.

The central estimate of the impact of smoking attributable ill-health on quality of life for the available conditions in 2015/16 was estimated as 89,207 YLD (with the low bound of the estimate being 63,231 YLD and the high bound 121,176 YLD). A majority of the quality of life impacts were experienced by women, 50,248.6 YLD compared to 38,958 YLD for men. Chronic obstructive pulmonary disease was the greatest single contributor to lost quality of life, accounting for 55,337 YLD.

9.3 Results

Converting the YLDs attributable to smoking to an intangible cost using the value of a statistical life year derived from Abelson (Abelson, 2008) gives a central estimate of the intangible cost of $25.6 billion (low bound $18.1 billion, high bound $34.7 billion). The plausible range of intangible costs of smoking attributable ill-health are quite wide, depending on the parameters used, ranging from $2.9 billion using the low bound estimate of YLD and the value of a statistical life year derived from PBS decisions, to $102.9 billion using the high bound estimate of YLD and the VoSLY derived from the US Department of Transport value of a statistical life.

Table 9.1: Years of Life Lost to Disability (YLD) from smoking attributable conditions

.	Male				Female			
Condition		Smoking attributable YLD				Smoking attributable YLD.		
.	Smoking attributable share	Central estimate	Low bound	High bound	Smoking attributable share	Central estimate	Low bound	High bound
Tuberculosis	5.90%	9.1	5.4	14.3	4.84%	8.7	5.1	13.6
Lip and oral cavity cancer	46.36%	307.1	155.7	517.6	43.43%	147.9	78.6	242.7
Nasopharynx cancer	47.71%	54.0	24.7	98.5	43.24%	6.2	2.9	12.3
Oesophageal cancer	45.23%	139.5	74.3	226.9	46.04%	79.7	47.4	119.7
Stomach cancer	11.01%	75.6	43.4	117.0	8.83%	36.0	20.3	55.4
Colon and rectum cancer	5.52%	286.7	189.7	403.9	6.68%	288.3	190.7	407.1
Liver cancer	8.03%	29.6	18.1	45.1	8.98%	10.5	6.9	15.0
Pancreatic cancer	17.00%	64.9	37.3	99.4	15.71%	54.8	33.3	80.7
Larynx cancer	65.56%	269.4	152.2	426.9	67.96%	53.4	28.6	89.4
Tracheal, bronchus, & lung cancer	73.01%	1,483.6	901.2	2,182.0	68.20%	957.5	559.4	1,447.8
Cervical cancer	0.00%	0.0	0.0	0.0	5.87%	27.9	15.5	45.0
Kidney cancer	12.10%	87.2	47.9	141.2	7.44%	27.2	13.0	47.1
Bladder cancer	25.81%	338.5	215.4	498.2	22.35%	95.9	58.5	145.8
Diabetes mellitus type 2	3.78%	2,074.5	1,370.5	2,967.2	1.07%	550.5	362.5	790.2
Otitis media	2.29%	31.9	16.6	55.5	2.13%	28.8	15.2	49.8
Hypertensive heart disease	11.78%	128.1	71.2	208.0	8.36%	155.3	92.1	242.2
Ischaemic heart disease	14.87%	1,508.3	1,006.8	2,155.0	14.14%	1,257.3	833.0	1,789.4
Other cardiovascular & circulatory diseases	9.36%	729.8	422.2	1,158.2	7.52%	732.2	425.9	1,169.7
Atrial fibrillation and flutter	10.36%	1,453.3	927.6	2,119.7	7.40%	785.2	499.1	1,148.9
Haemorrhagic stroke [a]	16.69%	1,026.4	725.9	1,352.3	18.04%	1,517.7	1,075.5	1,983.3
Ischaemic stroke [a]	11.35%	1,522.4	1,076.7	2,005.9	10.64%	1,796.7	1,273.3	2,348.0
Peripheral vascular disease	12.73%	86.5	40.0	156.2	12.44%	102.9	48.1	187.4
Influenza and pneumonia *	6.89%	671.8	352.8	1,150.9	7.04%	750.8	396.1	1,286.4
Lower respiratory illness	0.66%	1.7	0.8	3.1	0.58%	1.5	0.7	2.7
Chronic obstructive pulmonary disease	66.86%	21,581.1	15,984.7	28,151.4	71.46%	33,755.5	25,773.3	43,208.8
Asthma	10.86%	3,879.3	2,408.1	5,863.7	12.17%	5,786.8	3,646.5	8,577.9
Other chronic respiratory diseases	12.11%	154.5	97.1	224.2	12.99%	261.1	169.8	372.5
Rheumatoid arthritis	4.14%	129.4	74.0	199.1	4.01%	341.7	211.7	499.6
Fire injuries	13.60%	834.0	518.8	1,283.5	13.60%	630.7	388.8	972.2

Total Years of Life Lost to Disability		**38,958.0**	**26,959.2**	**53,825.0**		**50,248.6**	**36,271.7**	**67,350.6**

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 smoking calculated from cost of hospital separation data set out in Table 6.1 as a proportion of the total cost of separations for these conditions.

Note: [a] YLDs lost due to 'stroke' were allocated between ischaemic strokes and haemorrhagic stokes based on their relative share of the total hospital separation costs for strokes.

Table 9.2: Cost of smoking attributable ill-health

	Value of a Statistical Life Year from Abelson 2008			Value of a statistical life year derived from PBS criteria			Value of a statistical Life Year from US Department of Transportation		
Condition	**Central estimate $**	**Low bound $**	**High bound $**	**Central estimate $**	**Low bound $**	**High bound $**	**Central estimate $**	**Low bound $**	**High bound $**
Tuberculosis	5,117,316	3,004,493	8,002,430	829,717	487,146	1,297,506	15,161,999	8,901,957	23,710,250
Lip and oral cavity cancer	130,387,709	67,155,208	217,844,576	21,140,935	10,888,480	35,321,106	386,323,312	198,972,912	645,447,631
Nasopharynx cancer	17,264,607	7,904,763	31,765,471	2,799,266	1,281,671	5,150,422	51,152,981	23,420,876	94,117,323
Oesophageal cancer	62,789,137	34,866,115	99,313,748	10,180,569	5,653,158	16,102,634	186,036,763	103,304,162	294,254,851
Stomach cancer	31,997,081	18,257,332	49,400,004	5,187,975	2,960,226	8,009,668	94,803,555	54,094,309	146,366,350
Colon and rectum cancer	164,755,829	109,015,031	232,416,467	26,713,349	17,675,590	37,683,778	488,151,973	322,998,603	688,622,417
Liver cancer	11,478,652	7,166,060	17,230,149	1,861,137	1,161,898	2,793,679	34,009,883	21,232,185	51,050,886
Pancreatic cancer	34,288,206	20,213,051	51,591,079	5,559,456	3,277,324	8,364,927	101,591,887	59,888,871	152,858,246
Larynx cancer	92,517,486	51,794,046	147,929,971	15,000,694	8,397,836	23,985,221	274,118,334	153,459,612	438,298,954
Tracheal, bronchus, and lung cancer	699,501,331	418,558,020	1,040,132,570	113,416,460	67,864,587	168,646,075	2,072,539,451	1,240,137,752	3,081,789,400
Cervical cancer	7,996,729	4,442,617	12,899,851	1,296,582	720,322	2,091,569	23,693,358	13,162,946	38,220,729
Kidney cancer	32,773,420	17,465,272	53,947,686	5,313,850	2,831,802	8,747,025	97,103,756	51,747,530	159,840,594
Bladder cancer	124,472,653	78,471,883	184,560,277	20,181,874	12,723,354	29,924,422	368,797,703	232,502,878	546,830,203
Diabetes mellitus type 2	752,215,006	496,605,674	1,076,699,900	121,963,404	80,519,157	174,575,066	2,228,723,817	1,471,383,692	3,190,134,061
Otitis media	17,405,036	9,114,476	30,192,056	2,822,035	1,477,812	4,895,310	51,569,055	27,005,112	89,455,481
Hypertensive heart disease	81,193,861	46,793,101	129,002,665	13,164,693	7,586,988	20,916,366	240,567,776	138,642,407	382,219,590
Ischaemic heart disease	792,487,689	527,222,945	1,130,301,059	128,493,177	85,483,412	183,265,906	2,348,046,999	1,562,099,036	3,348,947,935
Other cardiovascular and circulatory diseases	418,943,799	243,041,614	667,052,645	67,927,137	39,406,529	108,155,262	1,241,280,771	720,103,467	1,976,397,846
Atrial fibrillation and flutter	641,436,298	408,820,558	936,615,642	104,001,853	66,285,765	151,861,942	1,900,499,648	1,211,286,810	2,775,081,022
Haemorrhagic stroke [a]	728,995,027	516,204,234	955,841,578	118,198,539	83,696,849	154,979,216	2,159,925,773	1,529,451,902	2,832,045,191
Ischaemic stroke [a]	951,086,365	673,395,071	1,247,607,939	154,208,211	109,183,617	202,285,928	2,817,956,059	1,995,189,700	3,696,514,302
Peripheral vascular disease	54,253,932	25,247,499	98,467,917	8,796,679	4,093,605	15,965,492	160,747,963	74,805,343	291,748,756
Influenza and pneumonia *	407,641,574	214,575,260	698,399,686	66,094,605	34,791,022	113,237,840	1,207,793,618	635,761,036	2,069,275,408
Lower respiratory illness	928,960	414,982	1,688,859	150,621	67,285	273,830	2,752,399	1,229,542	5,003,888
Chronic obstructive pulmonary disease	15,856,843,863	11,965,862,194	20,448,440,691	2,571,013,119	1,940,133,166	3,315,490,128	46,981,947,045	35,453,430,002	60,586,303,681
Asthma*	2,769,837,868	1,734,963,903	4,138,267,565	449,098,797	281,305,346	670,974,646	8,206,700,977	5,140,492,201	12,261,195,815
Other chronic respiratory diseases	119,069,882	76,480,444	170,969,410	19,305,874	12,400,464	27,720,813	352,789,933	226,602,483	506,562,077

Condition	Value of a Statistical Life Year from Abelson 2008			Value of a statistical life year derived from PBS criteria			Value of a statistical Life Year from US Department of Transportation		
	Central estimate $	Low bound $	High bound $	Central estimate $	Low bound $	High bound $	Central estimate $	Low bound $	High bound $
Rheumatoid arthritis	135,000,650	81,859,971	200,202,764	21,888,873	13,272,695	32,460,680	399,990,909	242,541,381	593,177,036
Fire injuries	419,713,672	260,061,776	646,379,683	68,051,963	42,166,161	104,803,368	1,243,561,813	770,532,188	1,915,146,311
Total intangible cost of ill-health	**25,562,393,635**	**18,118,977,592**	**34,723,164,337**	**4,144,661,445**	**2,937,793,265**	**5,629,979,827**	**75,738,339,514**	**53,684,380,897**	**102,880,616,235**

Source: VoSLY estimates (Abelson, 2008): (US Department of Transportation, 2015): (Community Affairs References Committee, 2015; Harris et al., 2008). 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 smoking calculated from cost of hospital separation data set out in Table 6.1 as a proportion of the total cost of separations for these conditions.

Note: [a] YLDs lost due to 'stroke' were allocated between ischaemic strokes and haemorrhagic stokes based on their relative share of the total hospital separation costs for strokes.

9.4 Conclusions

The intangible costs of ill-health were not included in the last national estimate of smoking-related costs (Collins and Lapsley, 2008) and, at $25.6 billion, greatly contributes to the cost estimation despite the fact that we were not able to identify a source of DALYs lost for all smoking-related conditions. Therefore, improved availability of data may well increase the estimate of intangible costs in future analyses. A recent review of studies conducted in the European Union noted that none of the eight studies on smoking included intangible costs, although three of 26 studies on alcohol included an intangible component (Barrio et al., 2017). Our global systematic review of the social costs of smoking published since 2008 found three studies that included a cost for intangibles (Makate et al., 2019). Lievens and colleagues used DALYs (valued at EUR 400,000 per DALY) to estimate intangible costs of premature death and disease (2017) and two Australian studies included the intangible costs of premature mortality (Collins and Lapsely, 2010; Whetton et al., 2013). The identification and costing of the intangible costs of ill-health in the current report thus makes an important contribution to our understanding of the true cost of tobacco in Australia and globally.

9.5 Limitations

As shown by the wide range of estimated costs ($2.9 billion to $102.9 billion) this aspect of the analysis is at a formative stage. Nevertheless, it is clear that the ill-health arising from smoking will have impacts on the quality of life of individuals, even if we are currently unable to accurately quantify these costs.

CHAPTER 10: REVENUE IMPACTS & INELIGIBLE COSTS

Steve Whetton & Robert J. Tait

10.1 Revenue impacts

In 2015/16 the Australian Government received $ 9.816 billion from tobacco excise[19] (Morrison and Cormann, 2017) and collected (for distribution to state and territory governments) a further estimated $1.546 billion from the goods and services tax (GST) on sales of tobacco products (GST calculated as 1/11th of total expenditure on tobacco products (Australian Bureau of Statistics, 2019)). The latter is only partly additional revenue as, in the absence of dependent use of tobacco, it is likely that household consumption expenditure would be roughly at its current level but with a different distribution of expenditure. GST revenue will only be a net increase in revenue to the extent that the alternative set of goods and services that would be purchased in the absence of smoking had a lower effective rate of GST than tobacco. Parenthetically, there is likely to be at least some net revenue gain from the states and territories as a result of spending on tobacco, as all expenditure on tobacco is subject to GST, whereas there are a number of areas of consumption spending that are GST exempt (broadly education, healthcare, rental of housing, financial services and fresh food). However, the exact level of additional revenue is not feasible to estimate without research identifying how smokers' spending would differ, if they were not purchasing tobacco products.

10.2 Costs not included in the analyses

10.2.1 Education, research and prevention programs

Consistent with international guidelines and previous analyses (Collins and Lapsley, 2008; Single et al., 2003) the costs of education, research and prevention programs, including media campaigns, are based on policy decisions rather than representing true costs of the use of tobacco and are thus not included in our estimated cost. However, the status of 'quitlines' is more ambiguous with demand potentially driven by media campaigns. Although they provide treatment service for smokers they may also contribute to prevention. We have estimated the cost of quitlines, but not included these in our total.

10.2.2 "Quitlines" and associated services

The costs for quitlines run by each State and Territory was sought from annual reports, budgets and finally from individual departments. Budgets were supplied on the basis that individual State and Territories were not identified. We noted that some quitlines also provided NRT services, which is a further reason for not including these in our overall cost, as this would 'double-count' the provision of NRT. There were also separate budget line items for targeted intensive services, such as for Aboriginal and Torres Strait Islanders, and pregnancies in high-risk populations. Where these were identified, they were totalled separately from the "standard" quitline figures. Budgets were obtained from five States or Territories. The average cost per daily smoker in each of these jurisdictions was calculated. From the mean value we pro-rated the cost in the remaining States and Territories per daily smoker and the high and low bounds were calculated from the highest and lowest cost per smoker where budgets were provided. In projecting these costs, we used the State and Territory populations for those aged at least 14 years in December 2015 (Australian Bureau of Statistics, 2016a) with the prevalence of daily smoking from the NDSHS (Australian Institute of Health and Welfare, 2017a). On this basis we estimated that the

[19] As there is little or no manufacturing of tobacco products in Australia, almost all tobacco excise is collected at the point of entry to Australia through what the Australian Taxation Office refers to as a 'Excise equivalent customs duty', however this report follows the Australian Government Budget Papers in referring to all such revenue as excise.

Quitline services cost $6.77 million (low bound $5.92 million: high bound $6.95 million). There was a further $3.18 million identified for specific targeted programs.

CHAPTER 11: DISCUSSION

Robert J. Tait, Steve Whetton & Steve Allsop

11.1 Findings

Despite the sustained decline in the prevalence of smoking in Australia over recent decades, an immense burden remains on individuals and society. The long lead-time of many smoking-related conditions means that this will persist into the future. With at least 388,500 smokers under the age of 25 years (Australian Bureau of Statistics, 2015b), the elimination of smoking-related illnesses and deaths is not imminently achievable. We estimate that the tangible cost of tobacco use to Australia in 2015/16 is $19.2 billion (with an estimated low bound of $16.3 billion and a high bound of $24.0 billion). Estimated intangible costs imposed a further $117.7 billion in costs on society for an estimated total cost of $136.9 billion (Table 11.1). The greatest share of the costs of smoking are borne by households, particularly by smokers, former smokers and their families.

In 2004/05, the cost of smoking was estimated at $31.5 billion: in 2015/16 that equates to $41.9 billion when adjusted for consumer price inflation (Australian Bureau of Statistics, 2016c; Collins and Lapsley, 2008). The current analysis did not attempt to replicate the demographic approach used in that estimate which involved "the calculation of the size and structure of a hypothetical population in which no drug abuse had occurred. The hypothetical population in this counterfactual situation is then compared with the actual population size and structure, as a basis for estimating drug abuse costs" (Collins and Lapsley, 2008, p.3). Instead, a more widely used approach was employed based on a recent systematic review of tobacco cost of illness studies carried out as part of the current study. Sixty-three reports produced between 2008 and 2018 were identified, of which 56 used a prevalence method (Makate et al., 2019), and only Collins and Lapsley (2008) had used a 'demographic' approach.

An estimated 20,032 deaths were attributable to smoking in 2015/16, a number that is consistent with previous estimates (Australian Institute of Health and Welfare, 2016b; Peto et al., 2015). The majority of these premature deaths were amongst males, and amongst those aged 65 years and older. Our central estimate for costs attributed to these deaths was based on valuing the intangible costs of premature mortality using a value of a statistical life of $4,598,059 ((Abelson, 2008), converted to 2015/16 values) with the high bound using the US Department of Transport's estimate of a value of a statistical life (derived from combining meta analyses of international valuation) converted to Australian dollar terms of $13,623,503 (US Department of Transportation, 2015). The intangible cost of premature smoking attributable deaths represented the largest single cost area from smoking. Table 11.2 compares this cost with an earlier estimate and describes the assumptions underpinning the calculation *versus* a recent alternative approach (Collins and Lapsley, 2008).

The costs of out-of-hospital care in the current report ($5.3 billion) were also markedly higher than the previous estimate, where a net saving of $63.4 million was estimated, primarily driven by savings in the nursing home sector of $177.3 million (Collins and Lapsley, 2008). However, that earlier estimate only included pharmaceuticals, ambulance and nursing homes: the addition of estimates for primary care and informal care account for a large portion ($3.4 billion) of the new costs attributed to smoking in this domain.

From a purely financial perspective, the Australian Government in 2015/16 raised more revenue in tobacco excise ($9.8 billion) than it lost through smoking attributable costs and loss of other revenue ($2.2 billion). However, this does not mean excise on tobacco is at its optimal level. Ideally excise rates would be set such that smokers fully internalise **any** smoking-related costs (whether borne by the Australian Government, State/Territory Governments, business or households) that they are not currently considering in their decision around quantity of smoking, although this should also be balanced by equity concerns as smokers are on average more likely to be socially and/or economically disadvantaged than the Australian population as a whole.

A recent analysis of the impact of premature mortality and reduced productivity by current Australian smokers on future productivity (e.g. an incidence study) estimated that this would result in a cost of $388 billion to GDP (Owen et al., 2018). In the current analysis, workplace absenteeism and presenteeism costs were only calculated for the target year, but these still amounted to $5.0 billion in 2015/16. This total was greater than the costs for inpatient care, an area that a lay audience might see as a far more significant source of smoking-related costs.

Table 11.1: Tangible and Intangible costs of smoking 2015/16

Cost areas	Central estimate $	Low bound &	High bound $
Tangible costs			
Tangible net costs of premature mortality (Chapter 4)			
NPV of lost economic output (non-employee)	3,388,405,429	3,388,405,429	3,388,405,429
Recruitment/training costs to employers	28,029,971	28,029,971	28,029,971
NPV of value of lost unpaid household work	623,688,044	623,688,044	623,688,044
NPV of healthcare costs avoided	-2,275,922,187	-2,275,922,187	0
Stillbirths (tangible costs)	5,219,865	5,219,865	5,219,865
Total tangible costs of premature mortality	**1,769,421,122**	**1,769,421,122**	**4,045,343,309**
Other workplace costs (Chapter 7)			
Absenteeism	4,225,841,638	3,286,344,623	5,238,439,528
Presenteeism	759,516,070	717,525,687	801,506,907
Total workplace costs	**4,985,357,708**	**4,003,870,310**	**6,039,946,435**
Healthcare (Chapters 5 and 6)			
Hospital separations	1,520,793,772		
Ambulance	200,211,738		
Emergency Department	252,653,735		
Outpatient care	289,291,963		
Primary healthcare	1,458,142,411	765,665,566	1,458,142,411
Pharmaceuticals for smoking-related conditions	451,117,678	451,117,678	638,909,711
Smoking cessation aids	153,486,565		
High-level residential care	293,560,781		
Other aged care services	126,576,403		
Informal carers	2,041,356,665	873,048,194	3,209,665,136
Total healthcare costs	**6,787,191,713**	**4,926,406,396**	**8,143,292,217**
Other tangible costs (Chapter 8)			
Fires	80,768,393	54,897,525	
Litter	73,322,292	46,644,584	100,000,000
Expenditure on tobacco by dependent smokers	5,547,172,745		
Total other tangible costs	**5,701,263,430**	**5,648,714,854**	**5,727,941,138**
TOTAL TANGIBLE COSTS	**19,243,233,973**	**16,348,412,682**	**23,956,523,099**
Intangible costs			
Intangible cost of premature mortality (Chapter 4)	92,108,544,749	49,058,706,233	272,906,689,958
Intangible cost of smoking attributable ill-health (Chapter 9)	25,562,393,635	2,937,793,265	102,880,616,235
TOTAL INTANGIBLE COSTS	**117,670,938,384**	**51,996,499,498**	**375,787,306,193**
TOTAL COSTS	**136,914,172,357**	**68,344,912,180**	**399,743,829,292**

May not sum due to rounding

11.2 Comparisons with the last Australian national estimate

A superficial examination of the headline figures from the Collins and Lapsley (2008) estimate of $31.5 billion and our current estimate of $136.9 billion, suggests a significant increase in the costs due to

smoking. However, the estimates are underpinned by different assumptions and epidemiological approaches. Most notably, in the estimation of the intangible costs of premature mortality where our estimate was $92.1 billion compared with the earlier estimate of $19.5 billion. If we applied our current parameters around the value to society of averting a year of life lost to the deaths identified in 2004/05, then the Collins and Lapsley figure of intangible costs would be $105.8 billion. Table 11.2 summarises the key cost areas and provides a brief explanation for the differences in each area.

The different methodologies make it difficult to separate changes due to the reduction in the prevalence of smoking against a background change in demographics and the costs of health services and treatment (typically beyond CPI). Further, the current study included new cost areas that did not appear in the earlier estimate (e.g. primary care, presenteeism, informal care, other aged care services and still-births) and attributed additional conditions (e.g. liver cancer, cataracts, rheumatoid arthritis, type 2 diabetes) to smoking to reflect the current evidence. Finally, it should be noted that although prevalence of smoking has fallen over the period 2004/05 to 2015/16, deaths attributable to smoking have not, reflecting the way in which harms from smoking can occur a considerable time after a person begins to smoke.

Table 11.2: Summary of the differences between the current study and Collins and Lapsley 2008

Area	Collins & Lapsley 2004/05 costs		Current study 2015/16 costs		Explanation of difference
	Total $ 2004/05	Per adult $ 2004/05	Total $, 2015/16	Per adult $, 2015/16	
			Tangible costs		
Labour in the workforce					.
Reduction in workforce (due to premature death)	4,969,500,000	325.71	3,416,435,400	183.645	The most significant driver of the lower workforce cost per adult in the current study is that the epidemiological calculations underpinning Collins and Lapsley's study result in a much higher number of years of life lost for a given number of deaths, and that a greater proportion of these years of life lost are amongst those of working age compared to the current study. One third of their estimated additional years of life lived in 2004/05 had there been no past tobacco attributable mortality were in the age group 20 to 64, whereas 20 per cent of the estimated smoking attributable deaths in the current study were in this age range. It is not possible to identify how much of this variation is driven by differences in smoking attributable deaths amongst younger persons over time and how much is driven by their calculation approach which did not estimate historical smoking related deaths by condition but rather assumed that the proportion of smoking attributable deaths by age group and gender calculated for 2004/05 was constant in the historical data. If non-smoking related deaths amongst younger persons from non-smoking related causes were historically higher (for example road crash deaths and other accidental deaths) then this approach would tend to overestimate the number of smoking attributable deaths among younger persons giving excess years of life lost estimates. There also appear to be an unusually high number of infant deaths in Collins and Lapsley's calculation, which given their approach of projecting back age specific death rates would tend to lower the average age of their estimated lives lost. For example Collins and Lapsley estimated that 229 infants died prematurely due to exposure to tobacco smoke in 2004/05, which would represent 55.4 per cent of average number of infant deaths in 2004 and 2005 (by way of contrast the estimated number of smoking attributable deaths amongst infants in the current study was 9.9, with an additional 92.9 stillbirths attributable to smoking – it is not possible to determine if Collins and Lapsley's estimate of smoking attributable deaths of infants included stillbirths; if their estimate of infant deaths does include stillbirth then their estimated 229 infant deaths would represent 9.7 per cent of infant deaths and stillbirths in 2004/05). The 'demographic' approach adopted by Collins and Lapsley to quantifying years of life lost in the study year due to substance use will also, all other factors being

					equal, increase the estimated reduction in workforce productivity for a given number of deaths as, unlike the current study, all workforce costs occur in the study year and therefore do not need to be discounted back to present value terms.
Costs of stillbirth	n.e.	n.e.	5,219,865	0.28	
Absenteeism	779,600,000	51.10	4,225,841,638	227.15	Self-reported rates of absenteeism amongst smokers and ex-smokers in the 2016 NDSHS are higher than in Bush and Wooden (1995) which was the source of absenteeism estimates for Collins and Lapsley. Wages have also increased at a rate greater than the CPI over the period between Collins and Lapsley's estimates and the current study.
Presenteeism	n.e.	n.e.	759,516,070	40.83	Collins and Lapsley were not able to estimate this cost item due to data limitations at the time of their study
Total	**5,749,100,000**	**376.81**	**8,407,012,973**	**451.91**	
Labour in the household					
Premature death	9,156,400,000	600.14	623,688,044	33.53	In addition to the factors noted above which result in a greater number of years of life lost using Collins and Lapsley's approaches, we have also adopted a more conservative approach than Collins and Lapsley by assuming no contribution to household labour from those aged less than 18 and from those aged 75 and older.
Sickness	686,700,000	45.01	n.e.	n.e.	
Total	**9,843,100,000**	645.14	**623,688,044**	**33.53**	
Consumption resources saved from premature death	-7,583,100,000	-497.02	n.e.	n.e.	Not included in the current analysis as it represents a transfer rather than a net cost at a societal level. Collins & Lapsley included as the resources are unavailable for investment or consumption purposes
Total paid & unpaid labour costs	**8,009,100,000**	**524.94**	**9,030,701,017**	**485.43**	
Healthcare (net)					
Hospital	669,600,000	43.89	1,520,793,772	81.75	Around half the additional cost of hospital separations is accounted for by the increased cost of a hospital separation between 2004/05 and 2015/16, with increases in population the next most significant driver, with the additional range of included conditions also contributing.
Other Medical	462,100,000	30.29	2,153,574,675	115.76	For costs included in both Collins and Lapsley and the current study, costs are higher in the current study due to a combination of increases in 'unit' costs in real terms, the increase in population, better capture of the full range of other medical costs, and the increase in the conditions for which there is evidence of partial causation by smoking. This was partially offset by a slightly more conservative

					approach to the share of other medical costs allocated to smoking attributable disease.
Nursing homes	436,600,000	28.62	293,560,781	15.78	Lower cost in the current study is due to the higher unit cost, higher population and increased number of smoking attributable conditions being more than offset by a more conservative estimate of the proportion of nursing home costs attributed to smoking (with dementia patients excluded from the cost calculations in the current study but included in Collins and Lapsley).
Other aged care services	n.e.	n.e.	126,576,403	6.80	
Informal care costs	n.e.	n.e.	2,041,356,665	109.73	Collins and Lapsley were not able to estimate this cost item due to data limitations at the time of their study
Pharmaceuticals	205,200,000	13.45	451,117,678	24.25	
Ambulances	62,500,000	4.10	200,211,738	10.76	The factors behind this difference are the same as those driving the increase in hospital separations costs
Healthcare costs saved	-1,517,600,000	-99.47	-2,275,922,187	-122.34	The estimated healthcare costs saved is increased in the current study by the higher population, the wider range of other medical costs included, and the increased age of smoking attributable deaths, but this is at least partially offset by the lower number of years of life lost due to smoking attributable deaths and the discounting of future costs back to current price terms.
Total net healthcare	**318,400,000**	**20.87**	**4,511,269,526**	**242.50**	
Fires					
Firefighters	46,900,000	3.07	48,789,910	2.62	Costs were increased in the current study due to a higher nominal unit cost of fires and increased population, but this was partially offset by a reduction in the proportion of fires estimated to have been caused by smoking due to the introduction of reduced ignition propensity cigarettes and lower rates of smoking indoors.
Property damage	16,100,000	1.06	31,978,484	1.72	
Total fires	**63,000,000**	**4.13**	**80,768,393**	**4.34**	
Litter	n.e.	n.e.	73,322,292	3.94	Collins and Lapsley were not able to estimate this cost item due to data limitations at the time of their study
Resources used in abusive consumption	3,635,600,000	238.29	5,547,172,745	298.18	Expenditure on tobacco products net of excise duty and GST appears to have increased at a per capita rate that was slightly higher than broader goods and services inflation over that period.
Total tangible costs	**12,026,200,000**	**788.23**	**19,243,233,973**	**1,034.39**	

Area	Collins & Lapsley 2004/05 costs		Current study 2015/16 costs		Explanation of difference
	Total $ 2004/05	Per adult $ 2004/05	Total $, 2015/16	Per adult $, 2015/16	
				Intangible costs	
Premature death	19,459,700,000	1,275.44	92,108,544,749	4,951.13	Intangible costs are the reason the current study has much higher costs of smoking than was the case in Collins and Lapsley. There are three components that drive this difference. First, Collins and Lapsley in calculating the value of a statistical life year divided the VoSL estimate by the expected years of life remaining at birth, rather than the conventional approach of calculating it based on an assumed 40 years of life remaining (see, for example, Abelson 2008). If the conventional approach to calculating the value of a statistical life year had been taken by Collins and Lapsley, their estimated intangible cost of premature death would have been $46.0 billion rather than $19.6 billion. The value of a statistical life is also higher in 2015/16 than in 2004/05 due to increases in disposable income per capita. Assuming society is willing to spend a consistent share of national income on averting premature deaths, then the 2015/16 value of a statistical life used by Collins and Lapsley would have been $2.9 million rather than $2 million. Applying this adjustment as well as the more conventional approach to calculating the value of a life year, suggests that Collins and Lapsley's intangible cost of mortality estimate would have been $67.8 billion in 2015/16 values. The final component of the difference is that current practice is to use higher values for a statistical life than were used in Collins and Lapsley, for example the current Commonwealth Government guidance is to use the value of a statistical life from Abelson (2008) which is $3-4 million in 2006/07 values. If the 2015/16 $ value of a statistical life derived from Abelson was applied to Collins and Lapsley's estimate of 369,161 years of life lost due to smoking, then the intangible cost would be $105.8 billion.
Intangible costs of ill-health			25,562,393,635	1,374.06	Collins and Lapsley were not able to estimate this cost item due to data limitations at the time of their study
Total intangible costs	**19,459,700,000**	**1,275.44**	**117,670,938,384**	**6,325.21**	
TOTAL COSTS	**31,485,900,000**	**2,063.67**	**136,914,172,357**	**7,359.60**	

* Based on 14,901 and 20,032 smoking attributed deaths and an implicit value of a statistical life of $1,305,932 and $4,598,059 respectively in Collins and Lapsley (2008) and the current study.
NDSHS = National Drug Strategy Household Survey: n.e. = not estimated: VoSL = Value of a statistical life

11.3 Future research and limitations

Across all the cost areas identified, difficulties were noted particularly in relation to the assumptions that are required in assigning costs to events in datasets not designed for this purpose. We highlight some specific areas that would benefit from further research.

11.3.1 Stillbirths

In relation to stillbirths, these were identified via the NHMD as part of the hospital separation data, with the relevant attributable fractions applied. However, there does not yet appear to be a consistent approach to costing stillbirth deaths and their impact on families or the subsequent economic cost to society. Clearly research or at least developing a consensus approach in this area would have ramifications across many health conditions and behaviours, beyond the current application. In the interim, we have included what should be regarded as a preliminary figure for the costs of stillbirths based on an Australian estimate of the tangible unit costs of stillbirth of $56,188 per case (PwC, 2016).

11.3.2 Informal carers

In 2009/10 the estimated value of unpaid or informal care work to the economy in Australia was $650.1 billion (Hoenig and Page, 2012). With respect to informal care, we believe that this report is the first occasion on which it has been included in the costs of smoking-related conditions. Condition-specific estimates indicate that family members bear a significant cost burden in caring for sick partners or relatives. The costs to informal carers include tangible costs such as reduced employment and out-of-pocket medical expenses plus the intangible costs of caring for a sick partner or family member. Overall, the availability of informal care provides a substantial cost saving to society as a whole.

The broad aggregation of conditions in the current datasets (Australian Bureau of Statistics, 2016d) meant that we were unable to assign costs for some smoking-related conditions. There is also a considerable degree of uncertainty regarding these cost estimates reflecting the different estimates provided by persons with disability and carers on the number of persons with disability receiving informal care. Resolving this apparent discrepancy would assist in clarifying the impact of informal care provision on the community. Despite these limitations, the cost to informal carers was one of the largest tangible imposts of smoking. Recognition of the role and contribution of informal carers is an important development in determining the true cost of many conditions.

11.3.3 Smoking and mental health

Life expectancy for those with mental health conditions is between 10 to 20 years less than the general population, with smoking the largest contributory factor in this difference (Harker and Cheeseman, 2016; Lawrence et al., 2013). People with no history of mental health disorders who also smoke have been found to have an increased risk of developing such disorders and people with mental health disorders are also more likely to smoke. (Jacka et al., 2012; Weinberger et al., 2017). While there was debate about research findings on smoking tobacco and schizophrenia, there is increasing evidence that there is a link. For example, there has been debate about potential self-management of the adverse effects of medication used in the management of schizophrenia and on the impact on medication choice and doses (Manzella et al., 2015) while others have more recently suggested a causal link with the expression of the disorder (Scott et al., 2018). Emerging evidence from longitudinal studies supports an argument that tobacco use may be a causal factor for some mental health conditions (Fluharty et al., 2016; Scott et al., 2018; Taylor et al., 2014). However, there is limited ability to explain the exact mechanisms of the relationships (Campion et al., 2008).

To summarise, while there is increasing evidence of a causative link between smoking and some aspects of mental illness, no study that we are aware of has yet established definitive *mechanisms*. Scott and colleagues speculated that nicotine is the most likely agent for a causal link and note the public health implications of switching to e-cigarettes (Scott et al., 2018). However, the search strategy outlined in Figure 2.1 failed to locate sufficient evidence for inclusion of any particular mental health condition. Continued research is needed to confirm causal links and to quantify the contribution of smoking to specific mental illnesses.

11.3.4 e-Cigarettes or 'vaping'

Given the lack of epidemiological data on the risks associated with their use, we specifically excluded e-cigarettes from the analysis. There is a dearth of evidence about the long-term health consequence of use of e-cigarettes or their impact on the prevalence of smoking. We were therefore unable to even speculate on the direction of the economic impact to Australia were they to become more widely available. Additional research on the direct impacts of e-cigarettes on the smoking status and health of their users, as well as additional research clarifying the extent to which the various harms of smoking arise from exposure to nicotine (which is still present in e-cigarettes) or other substances such as combustion products (which may not be present in e-cigarettes) appears warranted.

11.3.5 Quality of life

This study included an estimate of the intangible costs to the individual of suffering a smoking related disease. However, given that we were unable to quantify the costs of some significant conditions (e.g. macular degeneration, cataract, hip fractures), it likely underestimates the effects on quality of life for those who lose their sight or have reduced mobility.

Although the recommended tobacco control framework acknowledges the importance of the tangible loss of a breadwinner on family circumstances (World Health Organization, 2017), there are also intangible costs of being an informal carer, and reduced quality of life for family members living with a person who has a smoking-related disease or who dies from a smoking-related disease. Further, there are likely to be intangible costs of simply living with a person who smokes. While these costs may not be as significant or wide ranging as the impacts of living with a person dependent on alcohol or illicit drugs (Laslett et al., 2015; Nicosia et al., 2009; Orford et al., 2013; Tait et al., 2018), the prevalence of smoking means that many people will be impacted.

Caring for those with chronic conditions has significant impacts in terms of emotional distress, physical ill-health, lost social support and impaired relationships (Cruz et al., 2017). These need to be quantified in monetary terms and specific measurement tools have been developed to assess both the direct financial costs and the indirect costs to care-givers, but these tools do not appear to have been widely used (Al-Janabi et al., 2011; Hoefman et al., 2013). In addition to the burden incurred during active phases of illness or during treatment of chronic conditions, the potential for recurrence during periods of remission from cancer, can be a major psychological stressor for family members (and the cancer survivor) (Vivar et al., 2008).

11.3.6 Presenteeism

We were able to estimate the costs of presenteeism arising from poor health in reducing workplace performance, but not that associated with the time taken on breaks to smoke. While it seems plausible

to assume that these breaks will reduce productivity compared to a non-smoker, that assumption needs to be confirmed and the magnitude of the loss quantified.

In the USA, albeit with different health costs and workplace tobacco controls, secondhand exposure to smoke accounts for more than 3.5 per cent of lost productivity costs from smoking-related deaths (US Department of Health and Human Services, 2014). While workplace costs arising from deaths due to environmental smoke exposure are captured in Chapter 4 of this report, other ill-health impacts of environmental smoke on the workplace are not included. The restrictions on workplace smoking should reduce these costs in the future, but exposure can still occur elsewhere, particularly in the home.

11.4 'Ideal' data sets

The ideal dataset for a cost of illness study is largely determined by the use to which it will be put. As noted in Chapter 2, the data available for the current study is better suited to assessing the costs arising from smoking attributable *harms* that occur in 2015/16, rather than the cost that arise from tobacco consumed in 2015/16. That is, deaths and ill-health largely result from smoking (or exposure to secondhand smoke) potentially over decades prior to these events.

Whilst the available data give a good idea of current resource impacts of smoking, it is not the ideal dataset to use in identifying the avoidable cost of smoking (or the potential benefits of reducing smoking prevalence). As this is a common use for cost of illness studies, it would be valuable to have epidemiological data available that would support that type of forward-looking assessment.

In order to support assessments of the impacts of tobacco consumed in the study year, it would be necessary to have epidemiological data that identified what impact the level of smoking (by gender and age) has on the probability of developing smoking attributable disease in the future, with specific estimates of the lag structure. For example, data identifying that a year of daily smoking by (say) a 35 year old man results in an 'x' per cent chance of developing lung cancer in 1 years' time, a 'y' per cent chance of developing lung cancer in 5 years' time, and so on into the future over the expected years of life remaining of the smoking population in the study year. These estimates would be needed for each of the smoking attributable conditions (and those conditions partially prevented by smoking).

11.5 Specific populations

The prevalence of smoking varies markedly across the Australian population with differences observed for many socio-demographic characteristics including geographic location, socio-economic-status, employment status, educational attainment, household composition and sexual orientation (Australian Institute of Health and Welfare, 2017a). In addition, rates of smoking are much higher among those with mental health disorders and those with other types of drug dependence (Cooper et al., 2012; Guydish et al., 2016). However, we have only specifically addressed this issue with respect to mortality and morbidity among those identified as Aboriginal and Torres Strait Islander people in recognition that smoking is the single largest contributor to the gap in fatal disease burden between Aboriginal and Torres Strait Islander people and non-Aboriginal and Torres Strait Islander Australians (Australian Institute of Health and Welfare, 2016c).

We note that the relevant data from Victoria and the ACT do not include Indigenous status, and hence our costs will be an underestimate of the burden on Aboriginal and Torres Strait Islander people. From Table 4.3 there were 886.4 deaths or 120.9 per 100,000 Aboriginal and Torres Strait Islander people in

the States and Territories excluding Victoria and the ACT (Australian Bureau of Statistics, 2018e). If the same rate was applied to the 65,280 Aboriginal and Torres Strait Islander people in Victoria and the ACT, there would be an additional 78.9 deaths of Aboriginal and Torres Strait Islander people (a total of 25.6 additional deaths for Australia, with the remainder of the additional deaths among Aboriginal and Torres Strait Islander people reallocated from deaths recorded for other Australians). Thus, instead of representing 4.42 per cent of deaths (886 / 20,032), Aboriginal and Torres Strait Islander people would account for 4.81 per cent (965 / 20,063).

Using the same approach, the cost of hospital separations per Aboriginal and Torres Strait Islander person (excluding Victoria and the ACT) was $113.77. If this is applied to the 65,280 Aboriginal and Torres Strait Islander persons in Victoria and the ACT (Australian Bureau of Statistics, 2018e) there would be a further $7,426,764.45 added to the cost of in-patient separations of Aboriginal and Torres Strait Islander persons (with a net increase in the total cost of smoking attributable hospital separations of $3,678,639.52, with the remainder of the expected increase in costs of hospital separations Aboriginal and Torres Strait Islander people reallocated from costs recorded for other Australians). Clearly, both of these adjustments are crude and do not consider the possible differences between those living in the ACT and Victoria compared with other States and Territories: the estimates are solely intended to give an indicative quantum for the deaths and morbidity potentially attributable to Aboriginal and Torres Strait Islanders living in Victoria and the ACT.

11.6 Incidence of costs

In addition to the total social costs arising from use of tobacco, it is also interesting to understand which groups in society are facing the costs; this is known as the incidence of the costs. The costs can initially fall on one or more of three broad community groups:

- Households (whether consumers of the substance, or those harmed by another's consumption);
- Businesses; and,
- Government.

For instance, in relation to smoking the incidence of the costs may fall as follows:

- Smokers - (e.g. increased healthcare spending, reduced income from labour);
- Other individuals - (e.g. impacts of secondary tobacco, caring for a relative or friend with a smoking-related illness);
- Business - (e.g. a share of lost economic output from smoking-related mortality and absenteeism, and damage from smoking-attributable fires); and,
- Government – (e.g. healthcare costs).

Public finance literature makes the distinction between the legal (or initial) incidence and the economic (or effective) incidence of a cost. Legal incidence refers to who faces a legal requirement to pay the cost, however it does not take into account whether that cost can be subsequently passed on to other stakeholders. Economic incidence refers to who ultimately bears the cost after all the economic responses to its initial imposition have been worked through. For example, where they have market power, businesses may be able to pass on the costs of property damage, or lower workforce productivity, to consumers in the form of higher prices or to their workers in the form of lower wages. Whereas businesses which do not have market power will need to absorb the cost through lower margins. In

general, the economic incidence is preferred as it measures where the impacts of costs ultimately sit, rather than the group which is first affected by them.

Unfortunately, identifying the economic incidence of social costs arising from substance use is generally very difficult due to data limitations. Thus, social cost studies typically focus on the initial incidence of the costs, as these can be more clearly identified (Collins and Lapsley, 2008; Single et al., 2003). We follow that approach in this report. In their study into the social costs of substance use in 2004/05, Collins and Lapsley found that 50.3 per cent of the tangible social costs of smoking fell on households, 42.1 per cent on businesses and 7.6 per cent on governments (Collins and Lapsley, 2008) [20].

Table 11.3 illustrates the distribution of the estimated ***tangible*** social costs of smoking between different groups of stakeholders in the community. In this analysis, households are treated as one group, abstracting away from the question as to whether the cost burden is imposed on smokers themselves or on others. The assessment of incidence relies on a number of assumptions about the proportions of various cost items that are borne by specific stakeholders, and thus, the calculation should be treated as an approximation. Intangible costs are not included in this assessment, as by definition, all of the intangible costs fall on households. Households bear well over half of the total tangible costs of smoking (58.2%), with the next largest share borne by business (26.8%) and the Australian Government (11.4%).

The key assumptions about those costs that are split between stakeholder groups are:

- Lost economic output was split between stakeholders based on data from the national accounts on the distribution of the income measure of GDP (and between levels of government based on data from Government Financial Statistics) (Australian Bureau of Statistics, 2016e, 2019);
- Expenditures on healthcare (and savings from healthcare costs avoided) were split between stakeholder groups based on the data on funding source for healthcare (Australian Institute of Health and Welfare, 2017c);
- Expenditure on pharmaceuticals, and on smoking cessation aides was allocated based on expenditure share data from the PBS (Pharmaceutical Benefits Scheme, 2018b);
- Expenditure on high-level residential care, and on other aged care services was split between levels of government based on the expenditure shares from the Review of Government Services provision (Steering Committee for the Review of Government Service Provision, 2017b);
- Absenteeism was split between households and employers based on data on the proportion of employees not entitled to paid sick leave (allocated to households), with employers allocated the cost of employees entitled to sick leave, and of employees who were owner/managers of the business (Australian Bureau of Statistics, 2017b). The Australian Government and State / Territory / Local Government were allocated a share of employer costs based on their share of employees (Australian Bureau of Statistics, 2018d) with the remainder of employer costs allocated to business. Presenteeism costs were allocated on the same basis as employer costs of absenteeism; and,

[20] This allocation did not include the revenues from tobacco excise, which represent a transfer from households to the Australian Government. Collins and Lapsley did include these revenues in their estimate of the impact of smoking on the budget, which they estimated delivered a net increase to Australian Government surpluses of $2.8 billion in 2004/05 (e.g. the additional revenue was $2.8 billion greater than the costs borne by the Australian Government, (Collins and Lapsley, 2008)).

- Data on the cost of property lost due to fires was split based on the estimated share of property damage that occurs to households and to business premises (Steering Committee for the Review of Government Service Provision, 2017a).

All intangible costs are necessarily borne by individuals.

Table 11.3: Incidence of tangible cost of smoking between stakeholders

Area	Australian Government	State / Territory / Local Government	Businesses	Households	All of society
Tangible costs of premature mortality					
Net present value of lost economic output	331,683,910	129,888,956	1,006,605,400	1,920,227,163	3,388,405,429
Recruitment/training costs to employers	0	0	28,029,971	0	28,029,971
Stillbirth (tangible costs)	510,962	200,095	1,550,683	2,958,125	5,219,865
Net present value of lost unpaid household work	0	0	0	623,688,044	623,688,044
Net present value of healthcare costs avoided	-937,305,505	-593,284,424	0	-745,332,258	-2,275,922,187
Medical costs					
Hospital separations	552,689,817	635,515,109	0	332,588,846	1,520,793,772
Ambulance costs	16,201,486	144,150,306	0	39,859,947	200,211,738
Emergency Department costs	91,819,909	105,579,908	0	55,253,918	252,653,735
Outpatient care costs	105,135,045	120,890,430	0	63,266,488	289,291,963
Primary healthcare – general practice visits	429,165,344	0	0	79,044,257	508,209,601
Primary healthcare - Referred Medical services	825,832,953	0	0	124,099,857	949,932,811
Pharmaceuticals for smoking-related conditions	336,548,513	0	0	114,569,165	451,117,678
Smoking cessation aids	44,479,266	0	0	109,007,299	153,486,565
High-level residential care	281,537,576	12,023,205	0	0	293,560,781
Other aged care services	121,392,284	5,184,119	0	0	126,576,403
Informal carers	0	0	0	2,041,356,665	2,041,356,665
Workplace costs [a]					
Absenteeism	0	0	3,347,757,198	878,084,440	4,225,841,638
Presenteeism	0	0	759,516,070	0	759,516,070
Other costs					
Fires - property damage	0	0	19,683,292	12,295,192	31,978,484
Fires - firefighter costs	0	48,789,910	0	0	48,789,910
Litter	0	73,322,292	0	0	73,322,292
Expenditure by dependent smokers net of taxation	0	0	0	5,547,172,745	5,547,172,745
Total Tangible Costs	**2,199,691,561**	**682,259,905**	**5,163,142,614**	**11,198,139,893**	**19,243,233,973**
Proportion of tangible costs	**11.4%**	**3.5%**	**26.8%**	**58.2%**	**100.0%**

[a] Due to data limitations all employer costs from absenteeism and presenteeism have been reported under 'businesses', whereas in reality a proportion would impact on Government too.

11.7 Conclusions

The current project sought to update the estimated cost of tobacco use to Australia and to do this with a more widely implemented analytical method. Despite our best efforts to achieve this, it is important to acknowledge that considerable uncertainty remains in quantifying a number of harms. In the 55 years since the release of the first US Surgeon General's report (US Department of Health Education and Welfare, 1964) and nearly 70 years since the landmark papers by Doll and Hill and by Wynder and Graham (Doll and Hill, 1950; Wynder and Graham, 1950) our understanding of the extent of harms related to smoking continues to grow, but remains incomplete. Likewise, efforts at attributing costs to all those areas where these harms occur, continues to develop. This updated estimate of costs has a number of identified gaps and therefore should not be regarded as a definitive endpoint.

Despite enduring investment in strategies to reduce tobacco use, and significant reductions in smoking prevalence, there are still considerable adverse impacts on the health of individuals, and social and other costs to the whole community. With approximately 2.4 million daily smokers at the time of the 2016 National Drug Strategy Household survey, the scale of harm is still considerable, and smoking today has relevance for costs in the coming decades, because many of the costs of smoking are experienced years after the drug use commences. In twelve months (financial year 2015/16) the observed 20,032 deaths from smoking-related causes and the high number of smoking-related hospital inpatient episodes represent significant public health and human distress.

The estimated economic costs are considerable (tangible costs $19.2 billion; intangible costs $117.7 billion) but of course do not necessarily capture the human face of the morbidity and mortality, affecting individuals, carers of those who develop smoking related conditions, the professional health staff and the public whose well-being might also be affected. The costs have relevance to public amenity, workplace safety and productivity and health-care costs.

We have noted the methodological limitations to our study and in so doing recognise and identify areas where we need to enhance the research, and data, to enable more accurate assessment of harms and costs.

There is much to celebrate in the return on investment in strategies to prevent and reduce smoking tobacco in Australia in terms of reductions in prevalence. Nevertheless, smoking remains a critical challenge for the health and wellbeing of Australians. Harms accrued from smoking in previous decades continue to have impact today, and this report reinforces the need to continue to invest in strategies to prevent and reduce smoking, and the associated significant morbidity and mortality.

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ABBREVIATIONS

AR-DRG = Australian Refined Diagnosis Related Groups
ABS = Australian Bureau of Statistics
AF = aetiological or attributable fraction
AIWH = Australian Institute of Health and Welfare
BEACH = Bettering the Evaluation and Care of Health
BITRE = Bureau of Infrastructure, Transport and Region Economics
CAD = Canadian dollars
COPD = chronic obstructive pulmonary disease
CPI = Consumer Price Index
CPS = Cancer Society Prevention Study
CVD = cardio-vascular disease
DALY = disability adjusted life years
ED = emergency department
EUR = European currency unit
GBD = Global Burden of Disease
GBP = Great British pound
GDP = gross domestic product
GP = general practitioner
GST = Goods and services tax
HIV/AIDs = Human immunodeficiency virus / acquired immunodeficiency syndrome
IHD = ischaemic heart disease
NCETA = National Centre for Education and Training on Addiction
NPV = net present value
NRT = nicotine replacement therapy
OR = odds ratio
OTC = over-the-counter (medication)
PBS = Pharmaceutical Benefits Scheme
PYLL = person years life lost
Real = value or rate of change after adjusting for the rate of inflation
RoGS = Report on Government Services, published annually by the Productivity Commission
RPBS = Repatriation Pharmaceutical Benefits Scheme
RR = relative risk
SIR = smoking impact ratio
VoSL = value of a statistical life
VoSLY = value of a statistical life year
WHO = World Health Organization
YLL = years of life lost

APPENDICES

Appendix Chapter 1.1: Systematic review

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Tobacco Cost of Illness Studies: A Systematic Review

Appendix Chapter 2.1: Detailed methodology - Basis for inclusion of social costs

It is generally accepted that social cost/cost of illness studies of substance use should exclude any net private costs borne by the user themselves. This is because the standard assumption underpinning much economic analysis is that consumption decisions are made through a rational assessment of their benefits and costs, and any private costs incurred would be expected to have an equal or greater private benefit offsetting them. For example, it is reasonable to assume that when deciding to buy tickets to a sports game or concert that a consumer has not only considered the purchase price but has also factored in their expectation of the time and cost of travelling to and from the venue, any expected annoyance from queuing or congestion etc. (Cost benefit studies will include all of the purely private costs, but they will also attempt to quantify the increase in utility arising from the use of the substance).

Whilst there is a consensus around this approach for "normal" goods and services, there is considerable debate on how such studies should treat those costs incurred by users with a drug dependence. This situation does not necessary meet the criteria of a rational, fully informed, consumer which is the basis for excluding these costs from a social cost study; and therefore such costs cannot necessarily be considered as a purely private cost (or at least cannot be considered as a cost that can be assumed to have an at least equal benefit offsetting it). A good survey of the literature on this issue is included in Cawley and Ruhm (Cawley and Ruhm, 2011), and the discussion in this section draws on their work.

Some economists maintain that, even for those drugs that have the potential to cause dependence, harms borne by the substance user themselves should be excluded in assessing public policy approaches to the substance in question. The rationale for this approach is the view that these costs would have been fully internalised by the users in their consumption decisions. This contention rests on two key assumptions:

1) That users would have anticipated the possibility of a dependence developing and have internalised any potential costs associated with the potential for developing a drug dependence when they were making their initial consumption decisions, and that for those individuals the expected benefits of the consumptions must have outweighed the expected value of the potential costs, including any potential costs associated with dependence, e.g. they will have fully internalised the costs; and,
2) That dependent users are best characterised as normal consumers who, as a result of the dependence derive much higher utility from their use of the substance. This is because they gain utility not just from their current consumption of the substance on which they are dependent, but also from the "stock" of previous consumption. In effect, dependence is treated as a hysteretic process where each unit of consumption increases the value of future consumption.

This approach to considering costs to users of drugs of dependence is what is known as the rational addiction hypothesis, which was first set out in Becker and Murphy (1988), and is supported by a considerable body of empirical work (c.f. (Becker et al., 2008; Chaloupka, 1991)).

Some conclusions from the 'rational addiction' hypothesis are broadly accepted, for example the conclusion that a dependent user will still respond to price signals, both in the present but also anticipated future price changes. However, there are two key implications of the hypothesis which have attracted considerable criticism, namely the contentions that:

- dependent users' current consumption is optimal for them given current and anticipated future costs; and,

- that dependent consumers will be *more* responsive to permanent increases in price than non-dependent users (due to the importance of past "stocks" of consumption on current utility).

More formally the hypothesis postulates that the consumer maximises lifetime utility (U) at time t=0 subject to an expected budget constraint in a way that can be characterised by the following utility function:

$$U(0) = \int_0^T e^{-\sigma t} U[Y(t), C(t), S(t)]dt$$

where σ is a constant rate of time preference; t is the period of time, from t=0 (the present) to t=T (expected years of life remaining); C(t) is the consumption of the addictive good at time t; Y(t) is the consumption of all other goods at time t; and S(t) is the current "stock" of past consumption of the addictive good at time t.
The stock of past consumption evolves over time according to:

$$\dot{S}(t) = C(t) - \delta S(t) - h[D(t)]$$

where C(t) is the consumption of the addictive good at time t; δ is the depreciation rate in the addictive stock and D(t) is expenditure on the endogenous depreciation (appreciation) of the stock of the addictive good. Becker and Murphy (1988).

The key implication of the hypothesis for cost of illness studies is that **even if users can become dependent on the substance in question, any costs borne by the user should still be excluded from the social cost calculation as they would have been offset by private benefits**.

The 'rational addiction' model has been very influential in economic analysis of addiction since it was first proposed, and historically social cost studies of drugs of dependence have excluded most or all of the costs borne by the addict themselves (Makate et al. 2019).

However, the core assumptions that underpin the 'rational addiction' models treatment of drugs of dependence – smokers with perfect foresight making a fully rational and informed decision to commence and continue smoking – have been increasingly called into question based on the findings of empirical work with smokers and ex-smokers (U.S. National Cancer Institute and World Health Organization, 2016). Recent international findings suggest that about 90% of smokers regret having started smoking (Fong et al., 2004).

There is an increasing body of research that contends that the weight of the evidence from behavioural studies does not support critical underpinning assumptions of the 'rational addiction' hypothesis. This has led researchers to argue that current consumption levels for the drug of dependence are not necessarily optimal. The evidence presented to refute the assumption that current consumption is a rational optimisation of the costs and benefits of the study are data suggesting that consumers generally:

- Underestimate the probability that their individual consumption patterns will lead to dependence (Gruber and Köszegi, 2001; Kenkel, 1991);
- Hold incomplete information on the potential health impacts of consuming the drug in question, and in particular underestimate the potential impacts on themselves (Gruber and Köszegi, 2001; Kenkel, 1991; Khwaja et al., 2007; Smith et al., 2008; US Department of Health and Human Services, 1994);
- Have different preferences for tobacco over their lifetime, such as holding positive views about smoking when young but later wishing that they had not started smoking (this is more

formally known as time inconsistent preferences (Angeletos et al., 2001; Gruber and Köszegi, 2001; Laibson, 2001)); and,

- Engage in optimisation behaviours that can be characterised by 'bounded rationality', that is using 'rules of thumb' to make decisions or optimising using an incomplete information sets (Akerlof, 1991; Suranovic et al., 1999).

If any of the four departures from rational, fully informed consumers listed above do hold with respect to a potentially addictive (and potentially harmful) substance, then it can no longer be asserted that current consumption levels of the addictive good will maximise the lifetime utility of use to the dependent user.[21] Thus, at least some of the costs arising from dependence can justify public policy responses to reduce consumption to its optimal level for the user once all costs are fully taken into account. (U.S. National Cancer Institute and World Health Organization, 2016). This could involve, but is not limited to, decreasing availability, increasing price, or providing information to users and potential users.

Following this rationale, whilst costs to a dependent user are not strictly social costs, in that they are borne by the users themselves, but have not been included (or have only been partially included) in consumption decisions, and therefore cannot necessarily be assumed to have delivered an equal or greater benefit to the consumer to offset their costs. Such costs are often referred to as 'internalities'; costs to the user that were not factored into their consumption decision. Internality theory postulates that government policies should include both internal and external costs, such that changes in taxation levels can be justified even when there are no external costs as such interventions ensure that consumers are taking these costs into account in their decision making (U.S. National Cancer Institute and World Health Organization, 2016). The question then arises as to how, if at all, these costs should be included in a social cost study.

There is no consensus in the literature on how internalities should be incorporated into economic analyses such as social cost studies.

Many social cost studies continue to exclude costs borne by the substance user themselves either because the authors consider the 'rational addiction' hypothesis to still be a useful heuristic for considering individual behaviours, or due to the difficulty in identifying what net costs borne by the user should be included given that even for drugs of dependence consumers are likely to derive *some* utility from their consumption.

Another approach that is often taken is to include those cost borne by the consumers themselves that are most closely related to dependent use (potentially including their expenditure induced by dependence) but to disregard costs incurred by non-dependent users as the four departures from a rational utility maximising consumer are greatest in the presence of drug dependence. In some cases an attempt is made to identify the level of consumption (and therefore harm) that these consumers would face if they were not dependent (see, for example, the Productivity Commission's inquiry into the social costs of gambling in Australia (Productivity Commission, 1991)). In other cases, a subset of all costs borne by dependent users are treated as internalities. For example Collins and Lapsley (2008) included

[21] The rational addiction hypothesis still has considerable 'positive' value (that is in predicting behavioural responses to policy changes), for example it correctly predicts that increasing prices such as through taxation, will be effective at reducing smoking consumption despite the dependence forming nature of tobacco.

the intangible costs of premature mortality of all substance users, and the expenditure by dependent users on the drug of dependence.

The final approach that can be taken is to treat ***all*** costs borne by dependent consumers as social costs, on the basis that empirical research with smokers suggests that the assumptions underpinning rational utility maximisation are met amongst dependent consumers (see above), and as the evidence suggests that continued smoking by dependent smokers is driven by the dependence rather than by utility maximisation amongst consumers (US Department of Health and Human Services, 2010, p.9). If consumers are not aware of these costs, or have not consistently taken them into account in their consumption decisions, then there is no reason to assume that the harms associated with tobacco consumption will have been offset by a utility gain to tobacco consumers. Costs borne by non-dependent smokers as a result of their own smoking is still treated as a private cost and excluded from the analysis.

This latter approach has been adopted in the current study, and all costs borne by dependent smokers will be included in the social cost calculation.

Appendix Chapter 6.1: PBS Items used for calculating pharmaceutical costs

Condition	PBS item codes
Wet macular degeneration n = 8	10138N, 10373Y, 10374B, 10505X, 11307D, 1349B, 1382R, 2168D
COPD only n = 9	10059K, 10124W, 10156M, 10187E, 10188F, 10509D, 5134F, 5137J, 8626B
COPD and Asthma n = 61	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
Diabetes Type 2 n = 80	10011X, 10032B, 10033C, 10035E, 10038H, 10044P, 10045Q, 10048W, 10051B, 10055F, 10089B, 10090C, 10128C, 1426C, 1531N, 1533Q, 1711C, 1713E, 1761Q, 1762R, 1763T, 1801T, 1921D, 2062M, 2430X, 2440K, 2449X, 2873F, 2933J, 2939Q, 2944Y, 2986E, 2987F, 3387G, 3415R, 3423E, 3424F, 3439B, 5474D, 5475E, 5476F, 8084L, 8188Y, 8189B, 8212F, 8390N, 8435Y, 8450R, 8451T, 8452W, 8533D, 8535F, 8571D, 8607B, 8609D, 8689H, 8690J, 8694N, 8695P, 8696Q, 8810Q, 8811R, 8838E, 8874C, 8983T, 9039R, 9040T, 9059T, 9060W, 9061X, 9062Y, 9180E, 9181F, 9182G, 9224L, 9302N, 9435N, 9449H, 9450J, 9451K
Stroke Prevention n = 57	1010E, 10169F, 10414D, 10590J, 1076P, 1463B, 1466E, 2160Q, 2209G, 2211J, 2268J, 2275R, 2691P, 2735Y, 2744K, 2753X, 2769R, 2843P, 2844Q, 4076M, 4077N, 4078P, 4179Y, 4286N, 5018D, 5054B, 5061J, 5434B, 5435C, 5500L, 8202Q, 8262W, 8263X, 8264Y, 8358X, 8382E, 8510X, 8558K, 8639Q, 8640R, 8716R, 8959M, 8960N, 9296G, 9317J, 9318K, 9319L, 9320M, 9321N, 9322P, 9323Q, 9354H, 9465E, 9466F, 9467G, 9468H, 9469J
Smoking cessation therapies n = 17	5469W, 9128K, 9129L, 8465M, 8710K, 3414Q, 5572G, 5573H, 10076H, 5465P, 5571F, 4571N, 4572P, 4573Q, 4576W, 4577X, 4578Y
Heart disease (e.g. statins, Beta blocker, ACE inhibitor) n = 44	**Statins:** 8213G, 8214H, 8215J, 8521L, 9230T, 9231W, 9232X, 9233Y, 8881K, 8882L, 9483D, 9484E, 2574L, 2584B, 2590H, 2594M, 2606E, 2609H, 2628H, 2636R, 2011W, 2012X, 2013Y, 8173E, 8313M, 9241J, 9242K, 9243L, 9244M, 9245N **Beta blocker:** 1081X, 2243C, 1324Q, 1325R **ACE inhibitor:** 3050M, 3051N, 8704D, 9006B, 9007C, 9008D, 9346X, 9347Y, 9348B, 9349C
Rheumatoid arthritis n = 166	10056G, 10057H, 10058J, 10060L, 10064Q, 10067W, 10068X, 10071C, 10072D, 10073E, 10077J, 10078K, 10079L, 10081N, 10137M, 10179R, 10184B, 10193L, 10196P, 10238W, 10389T, 10396E, 10397F, 10399H, 10400J, 10404N, 10412B, 10413C, 10419J, 10420K, 10422M, 10511F, 10517M, 10576P, 10583B, 10591K, 10593M, 10703H, 10709P, 10719E, 10742J, 1220F, 1221G, 1419Q, 1423X, 1464C, 1476Q, 1481Y, 1482B, 1954W, 1963H, 1964J, 3425G, 3426H, 3428K, 3430M, 3432P, 3434R, 3436W, 3445H, 3446J, 3447K, 3448L, 3449M, 3450N, 4284L, 4613T, 4614W, 4615X, 5281Y, 5282B, 5283C, 5284D, 5605B, 5733R, 5734T, 5735W, 5753T, 5754W, 5755X, 5756Y, 5757B, 5758C, 6367D, 6397Q, 6448J, 6496X, 7257Y, 7258B, 7259C, 8637N, 8638P, 8737W, 8741C, 8778B, 8779C, 8961P, 8962Q, 8963R, 8964T, 8965W, 8966X, 9033K, 9034L, 9035M, 9036N, 9037P, 9077R, 9078T, 9085E, 9086F, 9087G, 9088H, 9089J, 9090K, 9091L, 9099X, 9100Y, 9101B, 9102C, 9103D, 9104E, 9186L, 9187M, 9188N, 9189P, 9190Q, 9191R, 9425C, 9426D, 9427E, 9428F, 9429G, 9431J, 9455P, 9456Q, 9457R, 9458T, 9459W, 9460X, 9461Y, 9462B, 9544H, 9611W, 9612X, 9613Y, 9615C, 9617E, 9621J, 9641K, 9654D, 9657G, 9658H, 9659J, 9661L, 9662M, 9663N, 9671B, 9672C, 9673D, 9674E, 9678J, 9679K, 9680L, 10263E, 10264F
Peptic ulcer n = 41	10295W, 10330Q, 10331R, 10343J, 10759G, 1158Y, 1326T, 1327W, 1504E, 1505F, 1937Y, 1977C, 1978D, 2055E, 2240X, 2241Y, 2487X, 2488Y, 3401B, 8007K, 8008L, 8162N, 8198L, 8331L, 8332M, 8333N, 8399C, 8507R, 8508T, 8509W, 8600P, 8601Q, 8738X, 8886Q, 9109K, 9110L, 9331D, 9423Y, 9424B, 9477T, 9478W

Appendix Chapter 6.2: Informal care and smoking attributable share of hospital costs

Condition	Smoking attributable share of hospital costs (%)
Bowel/colorectal cancer	9.4
Other neoplasms	29.0
Diabetes	18.8
Parkinson's disease	-7.8
Macular degeneration	12.9
Heart disease	63.7
Angina	63.7
Myocardial infarction (heart attack)	63.7
Other heart diseases	63.7
Hypertension (high blood pressure)	23.5
Stroke	56.8
Other diseases of the circulatory system	97.4
Emphysema Breathing difficulties/shortness of breath	64.0
Asthma	10.5
Chronic Airflow Limitation (CAL)	64.0
Stomach/duodenal ulcer	10.9
Arthritis and related disorders	4.3


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