An assessment of the economic cost of smoking in Ireland

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A report submitted by ICF International
in association with

DKM Economic Consultants

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Executive summary

This report presents a study to assess the economic cost of smoking in Ireland. The study was carried out for the Department of Health by ICF International. Research support was provided by DKM Economic Consultants (DKM). Professor Anne Ludbrook (University of Aberdeen, United Kingdom (UK)) provided expert advice on the methodology.

Purpose of the study

The purpose of this study is to contribute to the evidence base of tobacco consumption and its effects in Ireland, to help support the implementation of the recommendations made in The Tobacco Free Ireland report (2013). The research makes a meaningful contribution to the evidence base on the economic cost of smoking in Ireland. It is a particularly useful piece of research as:

- This type of study has not previously been carried out in an Irish setting;
- The majority of the studies worldwide do not cover the range of smoking related costs set out in the terms of reference. This means that they are likely to underestimate the costs associated with smoking; and
- A causal relationship to smoking has been established for more diseases than are covered in previous research.

Health effects of smoking

There is a large body of evidence on the relationship between smoking and health conditions. In total 41 conditions with a causal relationship with smoking were identified. These 41 conditions were used for the main analysis of the costs of smoking. There is also evidence of a suggested relationship between smoking and a further 21 health conditions. As the estimate of the health burden imposed by smoking presented in this report is based only conditions with a causal relationship it is likely to understate the total health impact.

The evidence base for the relationship between exposure to second-hand smoke and health conditions is also extensive. The cost analysis is based on the eight health conditions (four in adults and four in children) for which a causal relationship has been demonstrated. There is evidence suggestive of a relationship between exposure to second-hand smoke and a further 12 health conditions. This again means that the health burden estimated in this paper is likely to be an underestimate of the total health impact.

The decision to use only health conditions where a causal relationship has been inferred has been taken to preserve a conservative approach to the estimated economic cost.

Other societal impacts of tobacco use

Looking beyond the direct effects on human health, the review of evidence found evidence on a variety of impacts that smoking has on society. The evidence base is more robust for some of the impacts than others. There is a strong, peer-reviewed evidence base examining the impact on productivity lost as a result of smoking, particularly in relation to additional absence from work but also for smoking breaks. Data collected by the Department of the Environment, Community and Local Government enable the impact of smoking related fires to be examined.

The evidence on the cost of littering, the impact on demand for hospital transportation and the impact on carers is much weaker. There is a very small number of studies examining each impact. Using data that are collected for ambulance call-outs, it is possible to estimate a hospital transportation cost, though no studies have been located against which to benchmark this cost. Some studies in the UK and USA have attempted to estimate the cost of dealing with smoking related litter. These follow a similar methodology but do not cover the total costs of smoking related litter.

The impact of smoking on demand for (and public expenditure on) residential and social care has not been explored until recently and there is a lack of evidence in this area. Recent studies have attempted to assess the impact on social care in the same way as health impacts are assessed, by calculating relative risks and attributable proportions for smokers.

The estimated cost of smoking

It is estimated that, in 2013, 5,950 premature deaths can be attributed to smoking and exposure to second-hand smoke, along with over 200,000 hospital episodes[1]. The total cost to the health service is estimated to be over €460 million.

The total estimated cost of lost productivity is over €1 billion. This comprises productivity lost through smoking breaks, smokers taking additional absence from work and the premature death of employed workers. The largest proportion of the lost productivity from smoking is estimated to be from the premature death of employed individuals.

The cost of fires caused by smoking materials, domiciliary care and smoking related litter has also been estimated. These costs are smaller in value than the cost of healthcare and lost productivity.

An attempt has been made to estimate the loss of welfare to individuals from contracting health conditions and premature deaths attributable to smoking and to exposure to second-hand smoke. The value of loss of welfare is estimated to be over €9 billion.

Table ES1.1 Summary of costs of smoking in Ireland, 2013

Type of cost	Number	Cost (€m)
Deaths attributable to smoking and exposure to second-hand smoke	5,950	-
Hospital inpatient admissions	31,500	171
Hospital day case appointments	19,300	13
Hospital outpatient appointments	116,300	15
Hospital emergency department attendances	38,000	10
Primary care	-	256
Hospital transportation	12,700	1
Domiciliary care	-	40
Loss of productivity – smoking breaks	-	136
Loss of productivity – smokers' absence	-	224
Lost productivity – premature death	-	711
Fires	380	4
Fatalities from fires	1	2
Litter	-	69
Total costs	**-**	**1,653**

ICF calculations

[1] A hospital episode is a collective name for all hospital admissions, outpatient appointments and emergency department attendances

Table ES1.2 Value of loss of welfare due to smoking-related morbidity and mortality, 2013

Type of welfare loss	Cost (€m)
Loss of welfare from morbidity (QALY approach)	1,355
Loss of welfare from mortality (VoSL approach)	7,657
Total loss of welfare	**9,012**

ICF calculations

Findings

The costs of smoking estimated in this study have been compared to the existing literature from the UK, as most of the comparable studies were carried out in the UK. Direct comparison between the estimated cost of smoking in this study and previous studies is difficult. This is due to differences in the methodologies used and differences in scope.

In general, the estimated costs in this study tend to be higher than the costs reported in studies conducted in the UK. Reasons for these differences include:

- The estimate of health costs in this study covers more health conditions than have been included in previous studies from the UK.
- The cost data used for hospital treatment in Ireland is different to English data.
- The loss of productivity was measured in this study using Gross Value Added (GVA) per worker as a measure of productivity, rather than wages which were used in the studies in the UK. The value of GVA per job is higher than wages.

Differences in scope are also relevant. The cost of smoking estimated in this study included costs which have not been estimated in previous studies, including the cost of hospital transportation, domiciliary care and the loss of welfare to individuals from mortality and morbidity.

1 Introduction

This is the report of a study to assess the economic cost of smoking in Ireland. The analysis was commissioned by the Department of Health from ICF International (ICF). Research support was provided by DKM Economic Consultants (DKM). Professor Anne Ludbrook (University of Aberdeen, UK) provided expert advice on the methodology.

1.1 Purpose of the study

The purpose of this study is to contribute to the evidence base of tobacco consumption and its effects in Ireland, to help support the implementation of the recommendations made in The Tobacco Free Ireland report (2013). The study makes a meaningful contribution to the evidence base on the economic cost of smoking in Ireland. It is a particularly useful piece of research as:

- This type of study has not previously been carried out in an Irish setting;
- The majority of the studies worldwide do not cover the range of smoking related costs set out in the terms of reference. This means that they are likely to underestimate the costs associated with smoking; and
- A causal relationship to smoking has been established for more diseases than are covered in previous research.

1.2 Purpose and structure of this report

This report provides an estimate of the economic cost of smoking in Ireland. It considers the cost of smoking to Irish society, as distinct from the financial expenditure of smokers on smoking products. The estimated cost is based on: a literature review that examined the evidence of the cost of smoking; a data collection exercise that gathered information relevant to the estimation of costs; and, a modelling exercise in which the cost of smoking in Ireland in a single year was estimated.

The report is structured as follows:

- Section 2 details evidence of the health effects of tobacco use;
- Section 3 describes the various societal impacts of smoking beyond the immediate consequences for health;
- Section 4 briefly describes the methodology used to estimate the economic cost of smoking in Ireland (a more detailed description is presented in the technical annex which is bound separately) and presents the estimated cost of smoking;
- Section 5 shows the results from the sensitivity analysis carried out; and
- Section 6 summarises the findings from the research and compares this to other research carried out globally.

2 Health effects of smoking

This section presents the evidence on the health conditions (illness, injury, impairment, or physical or mental condition) associated with smoking and exposure to second-hand smoke. It does not present epidemiological evidence on how smoking relates to health conditions.

2.1 Health conditions associated with smoking

Research into the relationship between tobacco use and health conditions has been taking place for over 50 years. In 1964, the first report of the US Surgeon General on the relationship between smoking and health conditions was released. Knowledge of the health consequences of smoking and second-hand smoke has since expanded very significantly.

Tobacco smoke has been found to contain a mix of 7,000 chemicals, many of which are poisonous[2]. These include:

- Formaldehyde, benzene, polonium 210 and vinyl chloride, which are carcinogens;
- Chromium, arsenic, lead and cadmium, which are toxic to humans; and,
- Carbon monoxide, hydrogen cyanide, ammonia, butane and toluene, which are poisonous.

Chemicals found in tobacco smoke reach almost every organ in the body, causing a large number of health conditions.

"Smoking injures almost all bodily organs, and tragically this injury often leads to incurable disease and death." (US Surgeon General, 2004)

'Second-hand smoke'[3] refers to both the smoke released from both the burning end of a cigarette (or other tobacco product), and that which is exhaled by a smoker. Whilst it has a similar composition to 'mainstream'[4] smoke, it is three to four times more toxic per gram (WHO, 2009) due to the lower burning temperature. There is no established safe level of exposure to second-hand smoke (Surgeon General, 2006; IARC, 2009). Both the International Agency for Research on Cancer (IARC) and the US Environmental Protection Agency have labelled second-hand smoke as a carcinogen. The WHO states that:

"Scientific evidence has unequivocally established that exposure to tobacco smoke causes death, disease and disability" (WHO, 2009).

Toxins present in second-hand smoke are absorbed by, and remain in, materials and soft furnishings (such as upholstery). This leads to 'third-hand smoke' exposure, which can linger for some time.

2.1.1 Review methodology

A wide ranging literature review of the health effects of smoking was published by the US Surgeon General in 2014. It provides a meta-analysis of studies from around the world that examine the relationship between smoking and exposure to second-hand smoke and health conditions. The evidence in the report extends to 2013 (though cut-off dates vary by topic). The review provided here is based predominantly on this work. It includes new studies only where they meet all of the following conditions:

- Were published after the US Surgeon General's date cut-off; and,
- Were not included in the US Surgeon General's report;

[2] US Centre for Disease Control and Prevention (CDC), 2010. Available at http://www.cdc.gov/tobacco/data_statistics/sgr/2010/consumer_booklet/chemicals_smoke/

[3] There are different names for second-hand smoke. These include environmental tobacco smoke and passive smoking. The WHO uses second-hand smoke, therefore it has been used throughout this report

[4] Mainstream smoke is the vaporous by-product of burning tobacco products that is purposely taken into the lungs through the oral cavity

- Described a randomised control trial (RCT), controlled trial, meta-analysis, or systematic review; and,
- Covered the health effects of smoking or second-hand smoke.

The focus was on identifying studies which updated the findings of the US Surgeon General's report – either by identifying links to new conditions, or increasing the evidence base on a particular condition. A total of 43 articles were included. The full search methodology is provided in the technical annex to this report.

2.1.2 The strength of relationships, and assessing relative risk

As with all epidemiological research, there is a challenge in demonstrating a causal relationship between the presence of a given factor and consequent impacts. A causal link is stronger than a mere association. It implies that, in the absence of exposure, some fraction of cases or deaths would not occur, or would occur at a later age (US Surgeon General 2004). The challenge of differentiating between causality and association is well met by the research. The US Surgeon General's report (2014) classifies the strength of evidence as follows:

- Level 1: Evidence is *sufficient* to infer a causal relationship;
- Level 2: Evidence is *suggestive* but not sufficient to infer a causal relationship;
- Level 3: Evidence is *inadequate* to infer the presence or absence of a causal relationship (which encompasses evidence that is sparse, of poor quality, or conflicting); and,
- Level 4: Evidence is suggestive of no causal relationship.

Epidemiological studies typically examine relative risks (RR) and odds ratios (OR). These compare the risks of those exposed to a given factor (in this case smoking or exposure to second-hand smoke), to those not exposed. They are useful when trying to work out the impact of smoking.

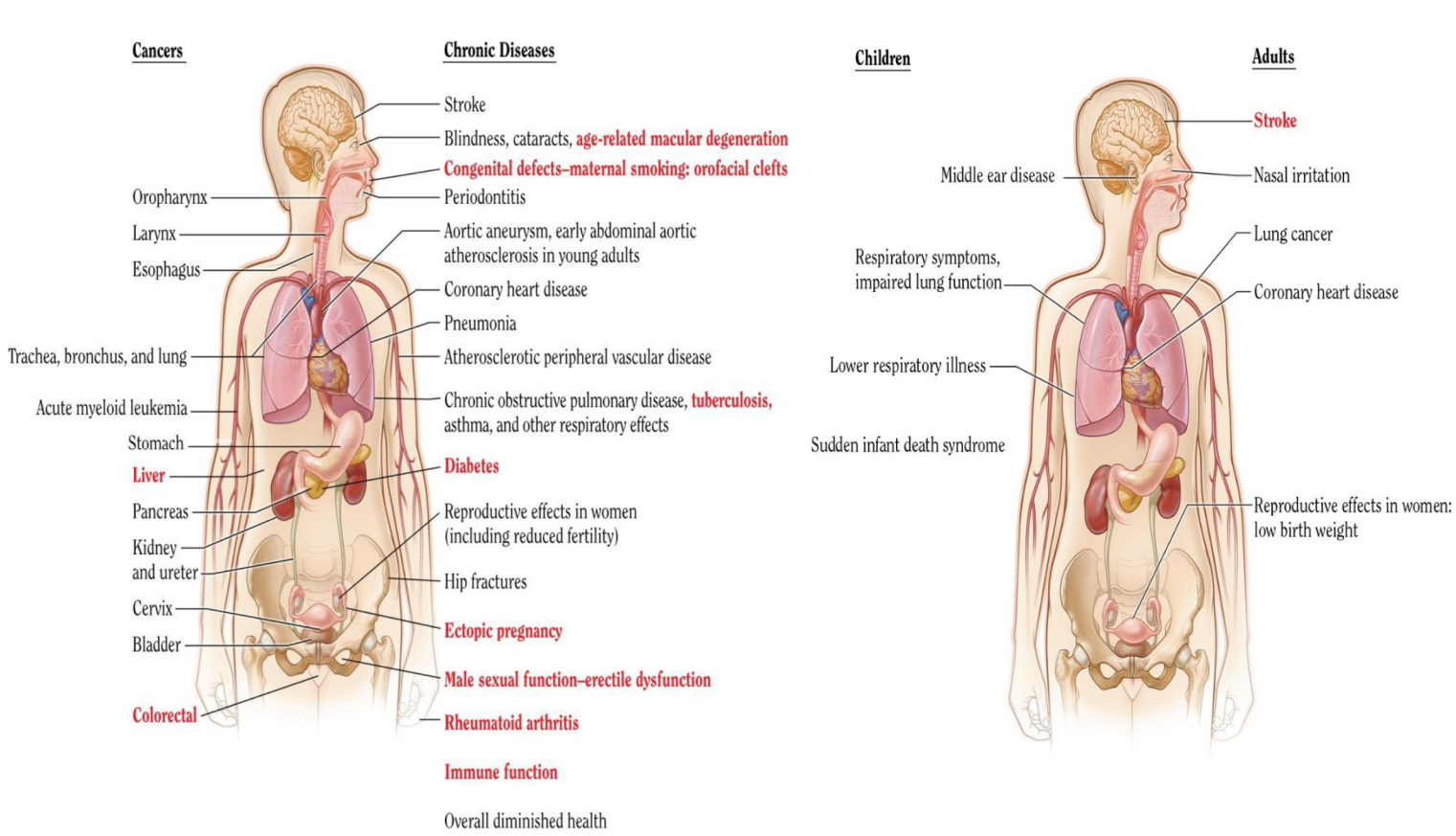
Relative risks do not, however, allow quick comparison of the impacts of different morbidities, or demonstrate the actual risk of developing a condition; additional analysis is needed. For example, the relative risks of developing coronary heart disease (CHD) and lung cancer from exposure to second-hand smoke reported by Oberg et al (2011) are 1.27 and 1.21[5] respectively. These similar relative risks result in very different annual worldwide deaths (of 379,000 for CHD and 21,400 for lung cancer) due to the different absolute risks for the two conditions. The risk of lung cancer among non-smokers is nearly zero; doubling it still gives a very low risk. The risk of CHD among the general population (non-smokers not exposed to second-hand smoke) is much higher (around one in five EU citizens die from the disease (European Heart Network 2012)). Doubling this absolute risk leads to greater morbidity and mortality at the population level[6].

Relative and absolute risks can also be expressed in terms of percentages. A relative risk of 1.25 can be expressed as a 25% increase in the risk of developing a given morbidity; a relative risk of 2 is a 100% increase, and a relative risk of 3 a 200% increase. Relative risk can also be referred to as the 'risk ratio'. Under some circumstances, the odds ratio is analogous to the relative risk, and is used in that way by some studies in this review.

[5] This is an odds ratio, but provides a sound estimate of relative risk

[6] The following two examples further illustrate this point. Firstly, that having a Computerised Tomography (CT) scan as a child could make leukaemia 200% more likely (RR=3). Secondly, that having one alcoholic drink a day can increase the risk of breast cancer by 5% (RR=1.05). The first sounds much more dangerous, but the absolute risk of developing leukaemia is so small (0.5 per 10,000 children aged 0-9), that the RR of 3 actually only leads to one additional case of leukaemia for every 10,000 children. Conversely, a 5% increase in breast cancer risk will lead to an extra 60 women per 10,000 developing breast cancer (www.cancerresearchuk.org accessed 11 December 2015)

Figure 2.1 Health effects related to smoking and exposure to second-hand smoke[7, 8]



[7] U.S. Department of Health and Human Services. The Health Consequences of Smoking: 50 Years of Progress. A Report of the Surgeon General. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2014. Printed with corrections, January 2014. available at: http://www.cdc.gov/tobacco/data_statistics/sgr/50th-anniversary/index.htm

[8] Text in black indicates health conditions where a causal relationship with smoking or exposure to second-hand smoke had been established in prior to the 2014 US Surgeon General report. Text in red indicates health conditions where a causal relationship has been newly established in the 2014 report

2.1.3 Health conditions with a demonstrated causal relationship with smoking

The US Surgeon General's report infers a causal relationship between smoking and 41 conditions: 12 types of cancer; four cardiovascular diseases; seven respiratory conditions; seven reproductive and developmental effects; and 11 other effects.

For 18 further conditions the report also presents evidence that is suggestive of a causal relationship, but is insufficient to infer a causal relationship. The literature review carried out for this study identified an additional ten conditions for which there is suggestive evidence of a relationship with smoking.

2.1.3.1 Cancers

A total of 12 cancers were identified by the US Surgeon General report as having a causal relationship with smoking. The majority of these relationships are well established. The link between lung cancer and smoking, for example, was discovered in the 1950s. The estimated relative risk of lung cancer being caused by smoking is, however, higher now than previously estimated. The 2014 report presented for the first time a causal relationship between smoking and liver and colorectal cancers. The 12 cancers where a causal relationship with smoking has been discovered are shown on the left hand side of Figure 2.1.

2.1.3.2 Cardiovascular disease

The US Surgeon General's report identifies a causal relationship between smoking and four main cardiovascular conditions: coronary heart disease; cerebrovascular disease; aortic aneurysm and Atherosclerosis. The Health and Social Care Information Centre (HSCIC) in the UK identified a causal relationship with a number of other heart and arterial diseases.

2.1.3.3 Respiratory disease

Smoking has long been linked to adverse effects on the respiratory system. It causes malignant and non-malignant diseases, exacerbates chronic lung diseases, and increases the risk of respiratory infections. The respiratory conditions for which a causal relationship with smoking has been established include: chronic obstructive pulmonary disease (COPD), chronic airway obstruction, pneumonia, influenza, mycobacterium tuberculosis and asthma. A causal relationship with smoking was established for a majority of conditions listed here before the 2014 Surgeon General's report was published. However, the relationship between smoking and tuberculosis was not categorised at Level 1 until 2014. Although smoking has long been considered a potential risk factor for tuberculosis, it is only recently that large case-control and cohort studies have proved this relationship.

A causal link was inferred between smoking and asthma but no relative risk or odds ratios were available in the research examined. This is because smoking exacerbates the condition and leads to poorer control of asthma, rather than causing asthma to develop.

2.1.3.4 Reproductive conditions

Tobacco use before and during pregnancy is a cause of reduced fertility as well as maternal, foetal, and infant morbidity and mortality. Maternal smoking has a causal relationship with seven conditions, including stillbirths, reduced fertility and ectopic pregnancies. Smoking among men is causally linked to erectile dysfunction. The relationship between smoking and many of these conditions is well established, but the 2014 Surgeon General report provided evidence of a causal relationship between smoking and both ectopic pregnancy and erectile dysfunction for the first time.

2.1.3.5 Other conditions

The 2014 US Surgeon General report identified a causal relationship between smoking and 11 other health conditions. These include conditions relating to the eyes and vision; musculo-skeletal conditions; conditions of the digestive system, metabolic conditions and general health. The report documented a causal relationship between smoking and type 2 diabetes and rheumatoid arthritis for the first time. Causal relationships were found to exist

between smoking and diminished health status, adverse surgical outcomes and negative effects on the immune system. No risk ratios were presented for these health effects.

A complete list of the health conditions with a causal relationship with smoking and the relative risk ratios (or odds ratios) is presented in the technical annex to this report (Annex 4).

2.1.4 Health conditions with a causal relationship with exposure to second-hand smoke

There is a growing body of evidence on the health impacts of exposure to second-hand smoke. There is Level 1 evidence that exposure to second-hand smoke causes the conditions presented in the right hand side of Figure 2.1. These include lung cancer, stroke and coronary heart disease among adults, and middle ear disease, respiratory conditions (including asthma) and Sudden Infant Death Syndrome (SIDS).

The dose, length and intensity of exposure are important to the determination of risk. Although there is no safe level of second-hand smoke exposure (US Surgeon General 2004; IARC 2009; WHO 2007), many studies assume a linear dose-response relationship. This has been demonstrated to be a sound conclusion for some morbidities for individuals exposed at home but has been less clearly evidenced for exposure at work (Behan et al 2005). In Ireland exposure at home is estimated to be 17% for non-smokers (Eurobarometer, 2010). There is a complete ban on smoking in the workplace and compliance with the legislation is very high. This means that exposure to second-hand smoke in the workplace is very low (reported at 2% in Eurobarometer 2012). Some health impacts may also be caused by historic exposure to second-hand smoke in the workplace.

2.1.5 Health conditions with an associated relationship with smoking and exposure to second-hand smoke

The US Surgeon General's report identified a further 18 conditions where the evidence was *suggestive* but not sufficient to infer a causal relationship. One of these (Crohn's disease) has been included in the causal relationship description due to evidence from the HSCIC in the UK of a causal relationship with smoking. Looking beyond the US Surgeon General report, the literature review for this study found a further 10 conditions where there is suggestive evidence of a relationship with smoking. A list of these conditions is presented in the technical annex (Annex 5).

2.1.6 There is a lack of evidence on causal relationships between use of alternative tobacco products and health conditions

A search was carried out for evidence of the health effects of the use of alternative tobacco products. There was some evidence on the effects of the use of snus (smokeless tobacco made from ground tobacco leaves). However, snus is illegal in Ireland, and not widely used. It was therefore not included in the analysis. No other additional evidence was found on the health effects of other tobacco products in Ireland (such as cigars and pipe tobacco).

2.2 Summary

There is a large body of evidence on the relationship between smoking and health conditions. In total 41 conditions with a causal relationship with smoking were identified. These 41 conditions were used for the main analysis of the costs of smoking. There is also evidence of a suggested relationship between smoking and a further 21 health conditions. As the estimate of the health burden imposed by smoking presented in this report is based on conditions with a proven causal relationship only it is likely to understate the total health impact.

The evidence base for the relationship between exposure to second-hand smoke and health conditions is also extensive. The cost analysis is based on the eight health conditions (four in adults and four in children) for which a causal relationship has been demonstrated. There is evidence suggestive of a relationship between exposure to second-hand smoke and a

further 12 health conditions. This again means that the health burden estimated in this paper is likely to be an underestimate of the total health impact.

The decision to use only health conditions where a causal relationship has been inferred has been taken to preserve a conservative approach to the estimated economic cost. A complete list of conditions with an associated relationship with smoking and exposure to second-hand smoke is presented in the technical annex.

3 Other societal impacts of tobacco use

This section presents the evidence of the effects of smoking on society, the demand for treatment of smoking-related health conditions and the premature mortality caused by smoking.

It considers the impact on:

- Demand for ancillary health services – care services and hospital transportation;
- Productivity; and
- Property fires;
- Littering and street cleaning services.

3.1 Demand for hospital transportation services

There is very little evidence on demand for hospital transport from patients with smoking related health conditions. The HSE does collect data on the number of emergency hospital transportation journeys. In 2013 a total of 281,003 emergency calls were received. The number of emergency calls are categorised. Clinical Status 1 ECHO calls relate to patients with life-threatening cardiac or respiratory arrest incidents, which are most likely to be related to smoking related conditions. In 2013 there were 2,923 Clinical Status 1 ECHO calls.

Information on the number of non-emergency patient transport trips is less readily available. These journeys are classified as category AS3 (inter-hospital transfer of patients to specialist facilities) and Public Transport Service (PTS) (community transfer service for patients requiring scheduled in-hospital care). There are 350,000 such journeys each year. The proportion relating to hospital transportation attributable to smoking and exposure to second-hand smoke is uncertain.

3.2 Demand for care services

There is comparatively little evidence on the relationship between the health conditions caused by smoking and demand for residential and social care services. Many people requiring social care suffer from a combination of health problems and so attribution of care needs to a specific condition is difficult. Additionally, the reasons why people need social care are not routinely recorded. This makes assessment of the drivers of demand for social care more challenging than it might otherwise be.

Some international research has attempted to estimate the cost of social care relating to smoking. The US Surgeon General's report (2014) estimated that 7.9 per cent of all nursing home care expenditure and 3.3 per cent of other services expenditure in the US (which includes home health care) arose as a result of smoking in 2009. This represents €8 billion in nursing home care and €6 billion for other services in the USA[9].

In the UK, research by Landman Economics (2014) compared the care needs of current and former smokers with those of people who have never smoked. Information from the UK is likely to be more relevant to Ireland than data from the USA as there are more similarities between the Irish health and social care systems and those in the UK. Data for this calculation were taken from the English Longitudinal Study of Ageing (ELSA) to calculate risk ratios for adults in receipt of domiciliary care and residential care. The research estimates that smokers require care, on average, nine years earlier than non-smokers, and being a smoker doubles the chances of receiving care. Using these risk ratios and evidence from the National Audit Social Care Intelligence Service (NASCIC) on spending, the cost of

[9] Currency exchange rate from www.xe.com; date of conversation: 10/06/2009

smoking to social care was estimated to be €742 million for local authorities and €557 million for self-funders in 2014 in the UK[10].

3.3 Productivity

Smoking and exposure to second-hand smoke have a negative effect on worker productivity. There are three main mechanisms for this:

- Smokers' productivity is lowered due to smoking breaks taken during the working day;
- Worker productivity is reduced by illness and absenteeism related to smoking; and
- Smoking is a cause of premature death, so shortening the working life of those affected.

3.3.1 Smoking breaks taking by smokers in working hours

A comprehensive review of the literature found that smoking employees take an additional four to thirty minutes in break time each day for on-the-job smoking (Javitz et al, 2006). A more recent meta-analysis of productivity loses due to smoking breaks estimated that time lost to unsanctioned smoking breaks ranges from 8 to 30 minutes per day (Berman et al, 2013). The review estimated the annual cost of smoking breaks per smoking employee as €2,325[11].

An Irish study (Madden, 2003) estimated that lost productivity due to smoking breaks would amount to €271m (this estimate was made prior to the introduction of the smoking ban). Studies in the UK have variously estimated the loss of productivity in the UK as a whole at €3.5 billion[12] to €8.9 billion in England alone[13], €296 million in Scotland[14], and €48 million to €74 million in Wales[15]. A further study estimated the cost of smoking breaks in the Europe Union at €13.5 billion in 2016[16].

3.3.2 Increased absence due to smoking

The studies described above generally reported the cost of absence due to smoking as well as the cost of smoking breaks. The meta-analysis by Berman, et al (2013)[17] collected data from recent studies in the USA which showed that the number of excess absences resulting from smoking varies between 2.3 and 2.9 days. Studies from outside the USA show a wider range in estimated absences due to smoking – in Sweden the average excess absence was estimated to be 7.7 days whereas in Taiwan it was found to be only slightly over a day[18]. The study from Taiwan estimated that the annual cost to employers of a smoking employee's excess absenteeism is €391, ranging from €135 to €435[19].

Other studies have estimated the additional number of days of absence for smoking workers and the cost of this absence for employers and the economy as a whole, including the studies for Ireland, and the UK. Madden (2003) estimated the cost of smoking-related

[10] Currency exchange rate from www.xe.com; date of conversation: 10/06/2014

[11] Currency exchange rate from www.xe.com; date of conversation: 10/06/2013

[12] Nash and Featherstone, (2010), Balancing Tobacco Income and costs in society; Currency exchange rate from www.xe.com; date of conversation: 10/06/2010

[13] Public Health England (2015) Health matters: smoking and quitting in England

[14] Featherstone et al, (2010) Up in Smoke: The economic cost of smoking in Scotland; Currency exchange rate from www.xe.com; date of conversation: 10/06/2010

[15] Grant, (2013) The economic cost of smoking to Wales: A review of existing evidence; Currency exchange rate from www.xe.com; date of conversation: 10/06/2013

[16] ICF (2013) Supplementary study to analyse and evaluate the health, social, economic and environmental impact of a possible EU initiative on the protection of workers' health from risks related to exposure to Environmental Tobacco Smoke at the workplace

[17] Berman, et al. (2013) Estimating the cost of a smoking employee

[18] Lundborg et al. (2007) Does smoking increase sick leave? Evidence using register data on Swedish workers; Tsai et al. (2005) Workplace smoking related absenteeism and productivity costs in Taiwan

[19] Currency exchange rate from www.xe.com; date of conversation: 10/06/2013

absenteeism in Ireland at around €114m for 2002; in the UK, Nash and Featherstone (2010) estimated the cost of additional absenteeism in the UK at €3 billion[20] (33 hours of lost productivity per smoker per year). The study for Scotland estimated the cost of absence at €254 million[21], and in Wales the estimate was €58 million[22].

3.3.3 Loss of productivity due to premature death

Some studies estimate the loss of productivity to an economy as a result of the premature death of smokers in the workforce. These studies all use a similar methodology – multiplying the years of productive life lost (up to a retirement age) by a value for annual productivity. The US Surgeon General report (2014) uses this approach to estimate that smoking cost the US economy €114 billion over a four year period (2005-2009)[23].

The UK studies mentioned all use the same methodology to estimate the loss of productivity in the UK, Scotland and Wales respectively. The methodology is similar to that described for the US Surgeon General report but UK data are used. These studies estimate the cost of lost productivity due to smoking caused premature death as: €4.9 billion[24] for the UK; €838 million[25] for Scotland and €366 million[26] for Wales.

3.4 Fires started by smoking materials

The Department of the Environment, Community and Local Government has produced statistics on the fire service for the past 10 years. These include data on the cost of running the fire service, the total number of fires and the causes of fires. In 2013, 230 fires were identified as having been caused by smoking material and 50 caused by matches. The cause of 8,121 fires was unidentified[27]. The number of fires attributable to smoking materials is thought to be under-estimated.

The Fire Service Statistics also provide information on the number of fatalities caused by fires in Ireland, and what the suspected cause of the fatal fire was. There were 24 fatalities from fires in 2013, of which one death was attributed to a fire started by smoking materials. It was not been possible for the fire service to determine the exact cause of the fires responsible for over half of the fatalities. Since 2010, the number of fatalities as a result of fires caused by smoking materials and matches has ranged between one and eight each year.

Some international studies have estimated the cost of fires caused by smoking. However, many of these estimates were made before the introduction of legislation banning smoking in the workplace. These studies include the cost of commercial fires due to smoking, which should no longer be an issue in Ireland as workplace smoking is illegal and the law is well observed. The research based on data following the introduction of legislation preventing smoking in the workplace includes the research from the UK mentioned above. The estimate for the whole of the UK was €614 million[28], for Scotland the estimated cost was €58

[20] Nash and Featherstone, (2010), Balancing Tobacco Income and costs in society; Currency exchange rate from www.xe.com; date of conversation: 10/06/2010

[21] Featherstone et al, (2010) Up in Smoke: The economic cost of smoking in Scotland; Currency exchange rate from www.xe.com; date of conversation: 10/06/2010

[22] Grant, (2013) The economic cost of smoking to Wales: A review of existing evidence; Currency exchange rate from www.xe.com; date of conversation: 10/06/2013

[23] Currency exchange rate from www.xe.com; date of conversation: 10/06/2010

[24] Nash and Featherstone, (2010), Balancing Tobacco Income and costs in society; Currency exchange rate from www.xe.com; date of conversation: 10/06/2010.

[25] Featherstone et al, (2010) Up in Smoke: The economic cost of smoking in Scotland; Currency exchange rate from www.xe.com; date of conversation: 10/06/2010

[26] Grant, (2013) The economic cost of smoking to Wales: A review of existing evidence; Currency exchange rate from www.xe.com; date of conversation: 10/06/2013

[27] These figures exclude fires in Dublin City, where the fire statistics are not broken down by cause

[28] Nash and Featherstone, (2010), Balancing tobacco income and costs in society; Currency exchange from www.xe.com; date of conversation 10/06/2010

million[29] and for Wales €45 million[30]. Research by Hall (2013) for the National Fire Protection Association in the USA estimated that there were 17,600 smoking-material related domestic fires in 2011, and that these led to 490 deaths and 1,300 casualties. The research did not estimate the cost of responding to these fires or for the injuries or deaths, but did estimate the property damage at €390 million[31].

3.5 Littering caused by smoking

There is some evidence on the littering caused by smoking, including information from Ireland. However, it is difficult to attribute costs to the littering caused by smoking.

A recent survey by the Department of the Environment, Community and Local Government examined the composition of litter in Ireland. It found that cigarette-related litter constituted the highest percentage (54.1 per cent) of litter pollution in 2013[32]. This was an increase of 1.4 percentage points on the 2012 equivalent. Nearly all of the smoking related litter (49.4 per cent of total litter) was cigarette ends. In 2004 cigarette ends were estimated to contribute 39.8% of national litter. The increase since 2004 could be associated with the ban on smoking in the workplace (i.e. more smokers now take their smoking breaks on the street rather than in the workplace). This research does not estimate the total volume of litter or cigarette ends or the costs associated with dealing with litter.

A 2011 study by Schneider et al estimated the cost of smoking related litter in San Francisco. The study estimated that 22.5% of litter was smoking related, which is lower than the proportion of litter which is related to smoking in Ireland. The cost of smoking related litter was estimated to be $0.20 per packet of cigarettes sold. Based on the results of this study, a tax of $0.20 per pack of cigarettes was introduced in San Francisco specifically to deal with the externalities of smoking related litter.

There is research from the UK estimating the cost of dealing with smoking related litter. A figure was calculated by multiplying the proportion of litter which was smoking related by the total cost of clearing litter. This provided an estimate of €414 million[33] for the whole of the UK. Separate studies estimated the cost of littering at €41 million[34] in Scotland and €31 million[35] in Wales.

Although these studies provide an estimate of the cost of smoking related litter, they do not necessarily reflect its true cost. Other effects of smoking related litter include loss of business, reductions in tourism and environmental damage (such as to wildlife). No research estimating these costs has been located. The research does not consider the proportion of street cleaning and litter management which would take place in the absence of any tobacco related litter. Noting that about 50% of litter in Ireland is smoking related, it seems unlikely that demand for street cleaning services would halve if there was no smoking related waste.

[29] Featherstone et al, (2010) Up in Smoke: The economic cost of smoking in Scotland; Currency exchange rate from www.xe.com; date of conversation: 10/06/2010

[30] Grant, (2013) The economic cost of smoking to Wales: A review of existing evidence; Currency exchange rate from www.xe.com; date of conversation: 10/06/2013

[31] Currency exchange from www.xe.com; date of conversation 10/06/2013

[32] This is based on an item count of litter pollution rather than on volume or weight of litter

[33] Nash and Featherstone, (2010), Balancing tobacco income and costs in society; Currency exchange from www.xe.com; date of conversation 10/06/2010

[34] Featherstone et al, (2010) Up in Smoke: The economic cost of smoking in Scotland; Currency exchange rate from www.xe.com; date of conversation: 10/06/2010

[35] Grant, (2013) The economic cost of smoking to Wales: A review of existing evidence; Currency exchange rate from www.xe.com; date of conversation: 10/06/2013

3.6 Welfare losses associated with smoking-related morbidity and mortality

The review of evidence found that many of the health conditions attributable to smoking were related to a deterioration in an individual's health status and quality of life. Such health impacts can restrict the individual's ability to live a full life and affect his or her welfare. The most common way in which this loss of welfare was measured was through use of Quality Adjusted Life Years (QALYs)[36] or Disability Adjusted Life Years (DALYs)[37].

There are few estimates of the welfare loss from smoking related morbidity and mortality in the literature. A study by Allender (2009) did attempt to capture this impact, estimating that 12% of Disability Adjusted Life Years (DALYs) lost in the UK in 2002 were as a result of smoking[38]. There is, however, a substantial literature demonstrating the loss of welfare due to conditions attributable to smoking. This demonstrates that there is a loss of welfare related to morbidity and morbidity attributable to smoking. The cost of premature deaths attributable to smoking has been estimated in much of the literature as the loss of productivity to the economy. However, this approach does not capture the benefits of avoiding the preventable death (due to smoking) of people who are not employed. The review found one study that did so, using a Value of Statistical Life (VoSL) approach to estimate the private cost of premature death due to smoking. The estimated private cost per pack of cigarettes consumed was €176 for men and €74 for women[39].

3.7 Summary

The review of evidence found research which estimates the impact of smoking on all the areas specified by the Department of Health for consideration in this study. The evidence base is more robust for some of the impacts than others. There is a strong, peer-reviewed evidence base examining the impact on productivity lost as a result of smoking, particularly in relation to additional absence from work but also for smoking breaks. Data collected by the Department of the Environment, Community and Local Government enable the impact of smoking related fires to be examined.

The evidence on the cost of littering, the impact on demand for hospital transportation and the impact on carers is much weaker. There is a very small number of studies examining each impact. Using data that are collected for ambulance call-outs, it is possible to estimate a hospital transportation cost, though no studies have been located against which to benchmark this cost. Some studies in the UK and USA have attempted to estimate the cost of dealing with smoking related litter. These follow a similar methodology but do not cover the total costs of smoking related litter.

The impact of smoking on demand for (and public expenditure on) residential and social care has not been explored until recently and there is a lack of evidence in this area. Recent studies have attempted to assess the impact on social care in the same way as health impacts are assessed, by calculating relative risks and attributable proportions for smokers.

[36] A QALY is a measure of the state of health of a person in which the benefits, in terms of length of life, are adjusted to reflect the quality of life. One QALY is equal to one year of life in perfect health https://www.nice.org.uk/glossary?letter=q

[37] DALYs can be thought of as a measurement of the gap between current health status and an ideal health situation where the entire population lives to an advanced age, free of disease and disability. http://www.who.int/healthinfo/global_burden_disease/metrics_daly/en/. It does not adjust for the quality of life for individuals

[38] Allender, S et al, (2009), The burden of smoking-related ill health in the UK

[39] Viscusi and Hersch (2008), The mortality cost to smokers; Currency exchange from www.xe.com; date of conversation 10/06/2006

4 The estimated cost of smoking

This section provides a brief description of the methodology used to estimate the cost of smoking and presents the results. A more detailed description of the methodology, including the equations and data manipulations required to make the estimate and a presentation of the data used are presented in the technical annex document that accompanies this report.

4.1 The burden on health and care services

4.1.1 The burden on health care services

The method adopted here for estimation of the health burden of smoking is shared by the US Surgeon General's report (2014), HSCIC's (2014) estimates of smoking related hospital admissions and deaths in the UK, the WHO and the most recent estimates for the number of smoking related deaths in Ireland (Howell, 2008).

The number of deaths, number of hospital admissions and day cases attributable to smoking was calculated for each condition separately. The first step was to calculate the proportion of deaths, hospital admissions and outpatient appointments that were attributable to smoking – the smoking attributable proportion (SAP). This was calculated using the smoking prevalence rate in Ireland, the proportion of the population who are ex-smokers and the relative risk ratio for each condition. The SAP for each condition was then multiplied by the total number of hospital admissions and deaths for each condition to give the total health burden of smoking.

The number of hospital admissions and deaths due to exposure to second-hand smoke was estimated using a two stage process which has been used previously by the US Surgeon General's report (2014), the WHO (2009)[40], the Smoke Free Partnership (2006)[41], RAND Europe (2009)[42] and ICF (2014). The approach used in this research used the SAP described above to estimate the burden on non-smokers. An attributable fraction for exposure to second-hand smoke was calculated using the rate of exposure to second-hand smoke and the relative risk ratios for each condition. The attributable fraction and the non-smoking health burden were multiplied together to estimate the number of deaths and hospital admissions attributable to exposure to second-hand smoke.

The health burden of smoking in Ireland was calculated using data from the Healthcare Pricing Office (HPO) for the number of hospital admissions and day cases, and the Central Statistics Office (CSO) for the number of deaths. The information from the HPO covers 93% of public healthcare provision in Ireland. No attempt has been made to extrapolate the cost of smoking to the health service so that the full health service is represented due to uncertainties around the missing data. The analysis only covered public healthcare provision, excluding private provision.

Table 4.1 and Table 4.2 present the health burden of smoking in Ireland. These suggest that 5,950 deaths in Ireland in 2013 can be attributed to smoking and exposure to second-hand smoke. There were an estimated 31,500 inpatient admissions attributable to smoking and exposure to second-hand smoke. This represents 3.3% of total hospital admissions, and resulted in 299,400 bed days. There were also 19,200 day cases attributable to smoking and exposure to second-hand smoke. These calculations are based only on health conditions that have a causal relationship with smoking and exposure to second-hand smoke.

In 2013 cancers were the most common cause of smoking related deaths in Ireland (49%). Cardiovascular diseases and respiratory conditions each led to a similar number of smoking

[40] World Health Organisation, (2009), WHO Report on the Global Tobacco Epidemic, 2009: Implementing smoke-free environments

[41] The Smoke Free Partnership, (2006), Lifting the Smokescreen, 10 reasons for a smoke free Europe

[42] RAND Europe, (2009), Analysis to support the Impact Assessment of the Commission's smoke-free initiatives

related deaths (25% and 26% respectively). The pattern was different for hospital inpatient admissions, with respiratory conditions causing the highest proportion of smoking related inpatient admissions (44%). The pattern was different again for day cases, with the largest proportion of smoking related hospital outpatient appointments attributed to 'other conditions' (38%). This demonstrates the differences in the types of the smoking related health conditions and how they are treated.

Additional classes of hospital appointments that could be attributed to smoking and exposure to second-hand smoke are outpatient appointments and emergency department attendances. Unfortunately, data on these two types of hospital episodes[43] are not classified by health condition. The number of outpatient appointments and emergency department attendances attributable to smoking and exposure to second-hand smoke was estimated by multiplying the total number of these appointments by the proportion of inpatient and day cases attributable to smoking (3.3%). This provided an estimate of 116,300 outpatient appointments and 38,000 emergency department attendances.

Table 4.1 Morbidity and mortality caused by smoking, 2013

Condition group	Deaths	Inpatient admissions	Number of bed days	Day cases
Cancers	2,860	6,350	81,430	7,190
Cardiovascular diseases	1,410	8,970	74,080	2,690
Respiratory conditions	1,530	13,660	115,510	1,950
Reproductive conditions	0	760	10,150	60
Other conditions	70	1,410	16,510	7,210
Total	5,860	31,150	297,690	19,100

HPO, CSO, ICF calculations – figures rounded to the nearest 10.

Table 4.2 Morbidity and mortality caused by exposure to second-hand smoke, 2013

Condition	Deaths	Inpatient admissions	Bed days	Day cases
Lung cancer	7	11	134	11
Coronary heart disease	68	213	1,670	89
Stroke	17	70	1,449	0
Middle ear disease (0-10 years)	0	25	44	109
Low birth weight	0	49	964	0
Total	92	368	4,260	209

HPO, CSO, ICF calculations

4.1.2 The cost to the health service

The number of hospital admissions, day cases, outpatient appointments and emergency department attendances attributable to smoking and exposure to second-hand smoke were multiplied by the cost of a hospital episode for each condition to estimate the cost to the health service. The average cost of hospital appointments was provided by the HSE. The estimated cost to secondary care is presented in Table 4.3.

[43] A hospital episode is a collective name for all hospital admissions, outpatient appointments and emergency department attendances

Table 4.3 Secondary care costs attributable to smoking and exposure to second-hand smoke, 2013

	Admissions	Cost of episodes (€m)
Inpatient admissions	31,520	171
Day cases	19,310	13
Outpatient appointments	116,300	15
Emergency department attendances	38,030	10
Total	205,150	210

HPO, ICF calculations

The cost of smoking to primary health care services was estimated using information from UK literature. It has been assumed that 55% of total smoking related health care costs are incurred in primary care and 45% in secondary care[44]. The estimates of secondary care costs described above have been used to estimate the primary care costs based on this assumption. The primary care costs attributable to smoking and exposure to second-hand smoke is estimated to be €256 million.

Table 4.4 Health service costs attributable to smoking and exposure to second-hand smoke, 2013

	Cost (€m)
Primary care	256
Secondary care	210
Total	466

ICF calculations

4.1.3 The cost of hospital transportation

The number of hospital transportation journeys that were caused by smoking was estimated by multiplying the number of Clinical Status 1 ECHO calls by the smoking (and second-hand smoke exposure) attributable proportion of cases of heart disease and chronic airway obstruction – the two conditions which are likely to cause Clinical Status 1 ECHO calls. This figure was then multiplied by the average cost of an emergency ambulance journey to give a total cost.

The number of non-urgent hospital transportation journeys was also estimated. This was calculated by multiplying the number of non-urgent ambulance journeys by the proportion of total hospital episodes caused by smoking (3.3%). This was then multiplied by the average cost of non-urgent hospital transport journey to give a total cost.

The cost of two types of hospital transportation attributable to smoking and exposure to second-hand smoke is estimated to be over €400,000. The majority of this cost relates to non-emergency transport, due to the larger number of journeys attributable to smoking and exposure to second-hand smoke (see Table 4.5).

[44] Callum, C. et al (2010) Estimating the cost of smoking to the NHS in England and the impact of declining prevalence

Table 4.5 The cost of hospital transportation caused by smoking, 2013

Type of transport	Number of journeys	Cost (€)
Emergency transport	1,240	348,000
Non-emergency transport	11,440	802,000
Total	12,690	1,150,000

ICF calculations

4.1.4 The cost of caring for patients with health conditions caused by tobacco use

4.1.4.1 Formal carers

The cost of formal caring required as a consequence of smoking-related conditions was estimated for domiciliary care only, as the research suggested that there was no significant relationship between smoking and the need for residential care. The cost was estimated by calculating the SAP for domiciliary care using the smoking prevalence rate and the relative risk ratio for domiciliary care. The SAP was then multiplied by the total government spending on domiciliary care. This assumes that spending on domiciliary care is divided equally among care users. This assumption does not accurately reflect reality, as some patients will receive more support than others. However, this simplifying assumption appears reasonable as smokers will be represented throughout the distribution of support – from small quantities to high levels of support.

The total budget for domiciliary care for 2013 is estimated at €324 million. The proportion of this budget which is attributable to smokers is put at just over 12%, meaning the cost of formal, domiciliary care is €39.8 million.

This covers only government spending on domiciliary care, not private spending or informal care. It also does not include the effect of past smoking on demand for domiciliary care. The figure is therefore likely to underestimate the true cost of domiciliary care attributable to smoking.

4.1.4.2 Informal care

An informal carer is a friend or family member who provides care for an individual without charge. Due to a lack of data available, the impact of smoking on the demand for informal care has been estimated qualitatively.

Interviews were carried out with three care charities to assess the level of informal care for smoking related health conditions in qualitative terms. The information collected through these interviews indicated that the most common smoking related health conditions leading to people needing informal care were COPD, cerebrovascular disease and diabetes. However, the picture is complicated by the fact that many patients suffer from co-morbidities.

One interviewee estimated that around 80% of care was carried out by family or friends. However, the level of care required by a patient varies considerably, depending age, stage of illness and the number of illnesses a patient has. Therefore, despite being able to estimate a unit cost for informal care (the interviewee estimated the value of informal care at between €20 and €25 per hour), no one was able to provide an estimate of the cost of informal care for smoking related conditions.

Two further costs of informal care were identified in qualitative interviews. These were the cost of informal carers giving up work to care for a patient (a loss of productivity to the economy and a loss of income to the individual) and increased government payments of a carer's allowance. Again it was not possible to provide a quantitative estimate for these costs.

4.2 The productivity cost of smoking

This section focuses on the loss of productivity from smoking breaks, the additional absence of smokers compared to non-smokers and the loss of productivity from premature deaths attributable to smoking and exposure to second-hand smoke.

4.2.1 The productivity loss from smoking breaks

The calculation of the loss of productivity from smoking breaks uses the following assumptions:

- Smokers smoke approximately 20% of the average daily cigarette consumption at work (Tsai et al, 2005 and Hallamore, 2006);
- Each smoking break involves exiting the workplace to smoke a cigarette and then returning back; and
- Each smoking break includes the actual smoking of the cigarette.

It has been assumed that each smoking break defined in this way takes, on average, eight minutes (Tsai et al, 2005; Parrot et al, 2000 and Berman et al, 2013). It has also been assumed that half of employers do not restrict smoking break time, with the rest strictly forbidding such practice. This is a conservative estimate of smoking break duration.

Using these assumptions, the loss of productivity through smoking breaks has been estimated by multiplying the number of smoking workers by the time lost each year for smoking breaks and the hourly value of productivity in Ireland (Gross Value Added (GVA) per hour).

The cost of productivity lost to smoking breaks in 2013 has been estimated using information on employment, productivity, smoking prevalence rate and the average number of cigarettes consumed per day. Assumptions have been made about the duration of smoking breaks and the number of businesses that allow smoking breaks.

The total cost of smoking breaks in 2013 is estimated at €136 million.

4.2.2 The cost of additional absence of smokers compared to non-smokers

The method used to estimate the cost of smokers taking more days off work than non-smokers is described below. The method involved three main steps:

- Calculation of absence rates for smokers and non-smokers;
- Calculation of the difference between the two rates; and
- Multiplication of smokers' extra days of absence by the average productivity.

It was assumed that smokers take on average 45% extra days of sick leave per year compared to non-smokers. This estimate was an average from two studies (Lundborg et al, 2007 and Weng et al, 2012) that were either based on large national datasets or on meta-analysis of multiple recent studies and used advanced statistical methods to control for confounding factors. These studies were considered as robust sources for assumptions because of their breadth and sophisticated estimation techniques.

The additional days of absence taken by smokers as compared to non-smokers was then multiplied by the number of hours worked in a day and the average GVA per hour. This gave a monetary value for the loss of productivity caused by smokers taking more days off work than non-smokers.

This estimate used data on the average number of day's absence per worker, the smoking prevalence rate, productivity and the level of employment. The calculation assumes that smokers have 45% more sick leave than non-smokers. This means that smokers are assumed to take over two days more sick leave per year than non-smokers

The cost of lost productivity due to smokers having more days off work due to illness than non-smokers has been estimated at €224 million for 2013

4.2.3 Other types of productivity loss

The cost of productivity lost due to premature death has been estimated, as in previous studies, by estimating:

- the number of deaths (attributable to smoking) of employed workers by multiplying the number of smoking-attributable deaths of working age individuals by the employment rate;
- the number of working years lost by multiplying the number of deaths of employed workers by the average number of working years lost for each condition (taken as 65 minus the average age of death for individuals aged under 65 for each condition)
- the total loss of productivity by multiplying the number of working years lost by the average annual productivity (GVA) per worker per year.

Using this approach, the total value of lost productivity from premature deaths relating to smoking and exposure to second hand smoke was €710 million.

4.3 The cost of fires started from smoking materials

The total number of fires caused by smoking materials was multiplied by the average cost of a fire in order to generate a value for the cost of fires started by smoking materials. These costs included the response, the property damage and injury cost of a fire. The cost of fatalities caused by fires started from smoking materials was calculated separately, by multiplying the number of deaths from fires caused by smoking materials by the VoSL.

The estimate of the cost of fires started by smoking materials and matches in 2013 is based on statistics published by the Department for Environment, Community and Local Government. The 380 fires attributed to smoking materials and matches in 2013[45] are estimated to have cost €3.9 million in response costs, property damage and cost of injuries.

There was a single fatality recorded from fires caused by smoking materials and matches in 2013. The value of the fatality is put at €2.0 million based on VoSL (this includes medical costs and the cost of lost productivity).

Table 4.6 Cost of fires caused by smoking materials and matches in Ireland, 2013

	Number	Cost (€m)
Fires	380	3.9
Fatalities from fires	1	2.0
Total	-	5.9

ICF calculations

4.4 The cost of smoking-related littering

The cost of littering caused by smoking materials was calculated by multiplying the street cleaning budget in each local authority area by the proportion[46] of litter which was smoking related materials.

The estimated cost of littering has been calculated using information from the Department of the Environment, Community and Local Government. It is estimated that a total of €128 million is spent by local authorities on street cleaning, and 54% of litter (by volume) is from smoking related materials.

[45] A total of 280 fires were reported to have been caused by smoking materials and fires in Ireland in 2013. However, this did not include fires in Dublin City. The Dublin statistics for 2013 were not broken down by cause of fire. Using statistics from previous years, it was estimated that 100 fires were caused by smoking materials and matches in 2013 in Dublin City. For more details see the technical annex

[46] This is based on an item count of litter pollution rather than on volume or weight of litter

The estimated cost of smoking related litter in 2013 is €69 million. This represents 1.7% of total local authority spending.

4.5 Welfare losses associated with smoking-related morbidity and mortality

4.5.1 The cost from loss of welfare from morbidity

The loss of welfare for individuals suffering from smoking related health conditions has been estimated using information from the literature. The calculation used estimates of health utility (Quality Adjusted Life Year measures, QALY) in the general population and measures of utility for patients with each smoking related health condition. The difference between the health utility measure of the general population and of those with a smoking related health condition was used as the estimated loss in utility per year. This was then multiplied by the expected future years of life with the condition to give a total loss of welfare. This was multiplied by the number of patients who had contracted the illness due to smoking. This was done for each condition separately. This loss of utility was then monetised using information from the National Centre for Pharmacoeconomics.

The loss of welfare for society associated with smoking related disease has been estimated for patients who contracted a smoking related disease in 2013. It was not possible to identify the number of such patients from the data on inpatient admissions or outpatient appointments as the data were available to the study only in aggregate form. Each unique patient could have multiple episodes and have contracted the health condition in a previous year.

To avoid the double counting of welfare losses it was assumed that the number of outpatient appointments that were first appointments for the condition (30%)[47] was a reasonable measure of the number of patients contracting the condition in 2013. Using this assumption and QALY utility values, and the expected number of life years following the diagnosis of the condition, the loss of welfare was estimated at nearly €1.4 billion. The majority of this loss of welfare relates to respiratory conditions (Table 4.7).

Table 4.7 The loss of welfare caused by smoking-related diseases, 2013

Condition group	First time patients	Value of lost utility (€m)
Cancers	9,300	348
Cardiovascular diseases	8,200	318
Respiratory conditions	10,700	562
Reproductive conditions	-	-
Other conditions	2,800	127
Total	31,000	1,355

HPO, ICF calculations

4.5.2 The cost of premature mortality

The economic value of the premature deaths caused by smoking and exposure to second-hand smoke was estimated by multiplying the number of deaths by the value of a statistical life (VoSL). The VoSL estimate used is based on equivalent UK figures (WebTAG). This estimate includes a cost for lost productivity, a human cost based on willingness to pay for reduced risk of death and a medical cost. The values for medical treatment and productivity were excluded from the calculation to avoid double counting, leaving the VoSL as €1.3 million. This was multiplied by the number of premature deaths caused by smoking and exposure to second hand smoke

The economic value of mortality was calculated by multiplying the VoSL by the number of premature deaths attributable to smoking and exposure to second-hand smoke. Using these

[47] Health and Social Care Information Centre (HSCIC) (2015) Hospital Outpatient Activity - 2013-14 (England)

assumptions, the 5,950 premature deaths attributable to smoking are valued at nearly €8 billion.

4.6 Summary

Different categories of smoking related costs have been presented in this section. Table 4.8 shows the costs by individual category.

In Table 4.9, the costs of smoking in Ireland have been consolidated into the following groups:

- Total health service costs – costs to the health service which have to be paid for by the government. These are: hospital inpatient admissions, day cases, outpatient appointments, emergency department attendances, primary care and hospital transportation costs.
- Domiciliary care.
- Costs relating to fires started by smoking materials
- Smoking related litter
- Lost productivity

Table 4.10 shows the private welfare losses relating to lower quality of life and premature death, as measured by the approaches described above.

Table 4.8 Costs of smoking in Ireland by type of cost, 2013

Type of cost	Number	Cost (€m)
Deaths attributable to smoking and exposure to second-hand smoke	5,950	-
Hospital inpatient admissions	31,500	171
Hospital day case appointments	19,300	13
Hospital outpatient appointments	116,300	15
Hospital emergency department attendances	38,000	10
Primary care	-	256
Hospital transportation	12,700	1
Domiciliary care	-	40
Loss of productivity – smoking breaks	-	136
Loss of productivity – smokers' absence	-	224
Lost productivity – premature death	-	711
Fires	380	4
Fatalities from fires	1	2
Litter	-	69
Total cost	**-**	**1,653**

ICF calculations

Table 4.9 Summary of cost of smoking, 2013

Type of cost	Cost (€m)
Total health service costs	467
Domiciliary care	40
Fires	6
Litter	69
Loss of productivity	1,071
Total cost	**1,653**

Table 4.10 Value of loss of welfare due to smoking-related morbidity and mortality, 2013

Type of welfare loss	Cost (€m)
Loss of welfare from morbidity (QALY approach)	1,355
Loss of welfare from mortality (VoSL approach)	7,657
Total loss of welfare	**9,012**

ICF calculations

5 Sensitivity analysis

A sensitivity analysis was carried out as part of the research. Sensitivity analysis is an exercise which looks at how using different assumptions in a calculation affect the outcome. In this case, the assumptions and values to calculate the economic impact of smoking in Ireland were varied. By doing this, a range of values of the cost of smoking in Ireland is derived. The expectation is that the true value will lie within this range.

A complete list of assumptions that have been varied for the sensitivity analysis is included in the technical annex. The assumptions for the health conditions included in the analysis, the cost of treatment, the cost to primary care, the loss of QALY utility and the loss of productivity have all been varied.

5.1 Results of sensitivity analysis

The results from the sensitivity analysis are presented in Table 5.1 and Table 5.2. These mirror the summary tables in section 4.6. They show that the largest degree of uncertainty relates to the impact of lost productivity from smoking breaks and smokers being absent from work more frequently than non-smokers.

Table 5.1 Summary of costs of smoking, 2013

Type of cost	Low estimate		Central estimate		High estimate	
	Number	Cost (€m)	Number	Cost (€m)	Number	Cost (€m)
Premature deaths	5,880	-	5,950	-	6,150	-
Hospital inpatient admissions	31,330	115	31,520	171	32,400	320
Hospital day case admissions	19,200	13	19,310	13	24,900	12
Hospital outpatient admissions	115,610	15	116,290	15	131,110	17
Hospital emergency department attendances	37,810	10	38,030	10	42,890	12
Primary care	-	76	-	256	-	441
Hospital transportation	11,380	1	11,440	1	12,900	1
Domiciliary care	-	40	-	40		40
Loss of productivity – smoking breaks	-	77	-	136	-	425
Loss of productivity – smokers' absence	-	157	-	224	-	426
Loss of productivity – premature death	-	706	-	711	-	773
Fires	380	4	380	4	463	5
Fatalities from fires	1	2	1	2	1	2
Litter	-	63	-	69	-	75
Total cost		**1,279**		**1,653**		**2,548**

ICF calculations

Table 5.2 Cost of smoking by type of cost, 2013

Type of cost	Low Cost (€m)	Central cost (€m)	High cost (€m)
Total health service costs	230	467	802
Domiciliary care	40	40	40
Fires	6	6	7
Litter	63	69	75
Loss of productivity	940	1,071	1,623
Total cost	**1,279**	**1,653**	**2,548**

ICF calculations

Table 5.3 Value of loss of welfare due to smoking-related morbidity and mortality, 2013

Type of welfare loss	Low Cost (€m)	Central cost (€m)	High cost (€m)
Loss of welfare from morbidity (QALY approach)	7,566	7,657	7,855
Loss of welfare from mortality (VoSL approach)	769	1,355	2,533
Total loss of welfare	**8,335**	**9,012**	**10,338**

ICF calculations

6 Findings

The research carried out for this study shows that smoking imposes a variety of costs on society. Many of these costs have been examined by researchers in different countries and there is a strong body of evidence of the costs of smoking. This evidence has been used, together with Irish data, to estimate the cost of smoking in Ireland. The key findings from the research are presented below, along with comparisons from other studies which have attempted to estimate the cost of smoking.

6.1 Health and care

ICF's best estimate is that in 2013:

- Smoking caused 5,860 premature deaths among smokers and a further 92 among non-smokers as a result of exposure to second-hand smoke;
- Smoking was the prime contributory factor in 31,200 hospital inpatient admissions and a further 370 admissions were triggered by exposure to second-hand smoke; a further 19,100 day cases were attributable to smoking and 210 were attributable to second-hand smoke;
- Smoking and exposure to second-hand smoke led to 116,300 hospital outpatient appointments among smokers and 38,000 emergency department attendances; and
- These episodes cost the health service in Ireland nearly €210 million.

The number of deaths attributable to smoking in England was also estimated by the HSCIC research. A total of 78,200 premature deaths in England were attributable to smoking, 148 deaths per 100,000 of the population. This compares to 130 deaths per 100,000 of the population in Ireland. The estimated number of deaths attributable to smoking in the population in England is broadly comparable to the estimated deaths attributable to smoking in Ireland.

The HSCIC in England has produced estimates of the number of hospital admissions attributable to smoking. A total of over 460,000 admissions were attributable to smoking, which is approximately 860 admissions per 100,000 of the population. This compares to approximately 1,110 admissions per 100,000 of the population in Ireland (including both inpatient and day cases). Two factors that will contribute to the difference between the episode rates in the two countries are:

- The estimate of the health burden in Ireland includes more conditions than were used in the HSCIC estimates for England; and
- The estimates for Ireland include hospital episodes for patients exposed to second-hand smoke.

The cost of smoking to the health service in Ireland was estimated to be around €467 million. The cost information published in the HSCIC estimates uses information from the research by Callum et al (2010), which estimated the cost in England at €3.9 billion[48]. The estimated cost to the health service in Ireland is €102 per person in the population. This is comparable to equivalent estimates provided by other studies. The cost per person in the population from the Callum study for England was approximately €77 in 2006. This estimate would be inflated for a 2013 value, but is still likely to be below the cost per person in Ireland. Two factors contributing to this difference are:

- The cost data used for hospital treatment in Ireland is different to English data; and
- The number of conditions assessed in this study is larger than the number used in the Callum study.

[48] Currency exchange rate from www.xe.com; date of conversation: 01/07/2006

The study in Wales estimated that the cost to the health service was slightly higher than the estimates in this study, with a cost of €122 per person in the population in 2012.

The cost to the health service has been estimated using information from the Healthcare Pricing Office in Ireland. This information source has data which covers 93% of public healthcare provision in Ireland. Therefore the estimates of the number of hospital episodes could be an underestimation. No attempt has been made to extrapolate the cost of smoking to the health service so that the full health service is represented due to uncertainties around the missing data. The analysis only covered public healthcare provision, excluding private provision. This is in-line with the approach used in studies in the UK.

The cost of hospital transportation for conditions attributable to smoking is estimated to be €1 million. Most of the cost was due to non-emergency hospital transportation. The cost of providing domiciliary care for patients due to smoking was estimated to be nearly €40 million. This was 12.2% of the total budget for domiciliary care services. This did not include privately funded domiciliary care or informal care, and is likely to be an underestimate. Comparable studies from other countries were not identified.

There is limited evidence of the effect of smoking on social care. Research cited in US Surgeon General report (2014) estimated the smoking attributable fraction for nursing home care was 7.9% in the USA, and Landman Economics (2014) estimated the smoking attributable fraction to be 11.9% in England. The smoking attributable proportion is slightly higher in Ireland than England despite the same approach being used.

6.2 Productivity

The total cost of smoking breaks in Ireland in 2013 is estimated at €136 million. The cost of lost productivity due to smokers taking more days off work than non-smokers is put at €224 million.

The total cost of smoking breaks in Ireland was estimated by Madden (2003). The estimate here is lower than the value in the Madden research (€271 million) which took place prior to the workplace smoking ban. The Madden study considered the effect on smoking breaks of the introduction of a workplace smoking ban, and the smoking prevalence rate and consumption of cigarettes has declined since these estimates

More recent studies in the UK have also produced higher estimates (for example €296 million in Scotland[49] and €3.5 billion in the UK[50]). This is the equivalent of €46 and €56 per person in the population respectively, compared to €30 per person in Ireland. The difference may be attributed to the fact that these other studies did not assume that a proportion of businesses allow smoking breaks and do not incur a loss of productivity, and a proportion of cigarette breaks occur in other breaks (such as lunch breaks).

Productivity loss estimates for smokers taking additional absence in this study are higher than a previous estimate from Madden (2003). Some of this change in costs is as the result of an increase in productivity in Ireland between 2003 and 2013. The estimated productivity loss per capita is comparable to those estimated for Scotland and the UK for 2010.

The estimated loss of productivity due to premature death is estimated as €711 million, or €155 per capita. This was estimated using a human capital approach, similar to those used in studies in the UK. This is a slightly higher estimate than those provided in UK studies (for example Nash and Featherstone and the ASH Local toolkit, estimating a cost of approximately €97 and €76 per capita respectively). This difference can be explained by two main differences in methodology: firstly, the smoking related health conditions used to estimate the number of deaths in the working population is different; secondly, the estimates in this study measures productivity using GVA per worker, whereas the UK studies use

[49] Featherstone et al, (2010) Up in Smoke The economic cost of smoking in Scotland; Currency exchange rate from www.xe.com; date of conversation: 10/06/2010

[50] Nash and Featherstone, (2010), Balancing Tobacco Income and costs in society; Currency exchange from www.xe.com; date of conversation 10/06/2010

wages to estimate productivity. GVA per worker measures the amount of value each worker adds to the economy, rather than what they are paid, and is a higher value than wages.

6.3 Fires

The 380 fires caused by smoking materials and matches in Ireland in 2013 cost €3.9 million. There was one fatality from a fire caused by smoking materials, which on a VoSL basis is valued at €2.0 million. The total cost of fires was estimated to be €1.3 per capita.

The costs of fires caused by smoking materials have been estimated in the UK. It is difficult to compare these to the figures for Ireland as the number of fatalities in fires attributed to smoking materials is much higher in the UK than in Ireland. This means that the cost of fires attributable to smoking in the UK is higher than the estimate for Ireland, for example the estimated cost in Wales was €16 per capita[51], in the UK €10 per capita[52] and in England €6 per capita[53].

6.4 Littering

The cost of smoking related littering is estimated to be €69 million. This represents 1.7% of local authority spending. The cost per capita in Ireland is higher than that provided by research in UK which used the same methodology. Some of the difference may be attributable to cost inflation (the estimates for the UK and Scotland are from 2010), but this does not explain the entire difference. The proportion of litter that is smoking related is similar in both the UK research and the method used here, therefore the difference between the estimates is liked to be caused by differences in the level of spending on street cleaning in the UK and Ireland.

6.5 Loss of welfare

The loss of welfare from premature death was estimated to be €7.7 billion. This was calculated using a VoSL approach. The loss of welfare from premature deaths attributable to smoking and exposure to second-hand smoke is not estimated in the studies from the UK, which focus on the cost of premature death from a human capital approach. However, this approach only values life for employed individuals, which will underestimate the true cost of premature death. Therefore an attempt has been made to capture this impact.

There is also a loss of welfare from individuals contracting a health condition attributable to smoking or exposure to second-hand smoke. This is due to individuals being in a worse state of health, which can restrict their ability to live a full life. Again, this effect is not generally captured in the research from the UK. A study by Allender (2009) did attempt to capture this impact, estimating that 12% of Disability Adjusted Life Years (DALYs) lost in the UK in 2002 were as a result of smoking[54]. In this study, the loss of welfare from morbidity was estimated using a QALY approach, with the total cost estimated to be €1.4 billion. However, this cost is not directly comparable to other studies.

[51] Grant, (2013) The economic cost of smoking to Wales: A review of existing evidence; Currency exchange rate from www.xe.com; date of conversation: 10/06/2013

[52] Nash and Featherstone, (2010), Balancing Tobacco Income and costs in society; Currency exchange from www.xe.com; date of conversation 10/06/2010

[53] ASH (2015) The Local Cost of Tobacco: Ready Reckoner

[54] Allender, S et al, (2009), The burden of smoking-related ill health in the UK

6.6 Summary

Several studies have attempted to estimate the cost of smoking in different countries, and most use a similar methodology. There is no consistent approach through the evidence base. This is due to differences among countries and data sources available, and new research which allows a broader range of costs to be considered. For example, this study has examined the cost of hospital transport and domiciliary care, which have not been calculated previously. Additionally, it has been possible to consider the health effects of a wider range of health conditions than previous research, due to developments in the scientific literature.