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Counting the Toll of Smoking-Attributable Hospitalisations

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Abstract

Aim
In Ireland, 20% of adults smoke. Many current and ex-smokers live with ill-health and disability as a result of smoking, and this study aimed to quantify the extent of smoking-related hospitalisations in Irish publicly-funded hospitals.
Methods
A population attributable fractions approach was used in this analysis utilising smoking prevalence data from the Healthy Ireland Survey and combining this with internationally-recognised relative-risks for current and past smoking, and hospitalisation data and hospital base costs data sourced from HIPE, for the years 2011-2016.
Results
In 2016, there were 21,486 day case admissions, 33,615 inpatient hospital admissions consuming 309,117 bed days, attributable to smoking and exposure to second-hand smoke, with an estimated cost of €172 million in publicly funded hospitals. This represents 2% of day case admissions, 5% of inpatient admissions, and 8% of inpatient bed days for that year.
Conclusion
Smoking continues to cause a considerable impact on hospital services in Ireland.

Introduction
Despite progress, tobacco consumption continues to cause a global epidemic of disability, ill-health and premature death. Latest figures from the World Health Organization (WHO) report that 7 million people die each year as a result of tobacco; more than 6 million of these deaths are as a direct result of smoking, with approximately 900,000 deaths among non-smokers as a result of exposure to second-hand smoke (SHS).[1] In Ireland, in 2016, it is estimated that almost 5,950 people died as a direct result of smoking with an additional 100 deaths estimated to be as a result of exposure to SHS.[2]

In 2018, 20% of Irish adults (aged 15+ years) currently smoke, with slightly higher smoking rates reported among males (22%) than females (17%).[3] While there has been a reduction in smoking prevalence in recent years, continued progress is required since *Tobacco-Free Ireland*, government policy on tobacco control, sets an ambitious target for Ireland to be tobacco-free (smoking prevalence <5%) by 2025.[4]

It is over 50 years now, since the first studies detailing the causal relationships between smoking and ill-health were published.[5,6] Since then, this body of evidence on the health effects of smoking and exposure to second-hand smoke has grown substantially with a causal relationship now established between smoking and nearly all organs of the human body, and to foetal harm. [7] Population Attributable Fraction (PAF) methods, which assess public health

impact relative to the risk associated with the exposure and the prevalence of exposure in the population, can be useful for reporting the burden of ill-health due to modifiable risk factors, such as smoking.[8] In England, for example, National Health Service (NHS) Digital and Public Health England (PHE) regularly report on national and local smoking attributable hospitalisations to support health policy and planning.[9,10]

This study aimed to estimate hospitalisations and associated direct costs for conditions attributed to smoking and exposure to SHS in Irish publicly funded hospitals in 2016, as well as some comparisons over a six-year period to 2011.

Methods

Standard epidemiological procedures for PAF estimation are well-described and were applied in this study,[11, 12] and are similar to previously published studies of smoking attributable burden in Ireland.[13]

Firstly, disease-specific Irish PAFs for smoking were calculated using the formula below:

$$a = \frac{[p_{cur}(r_{cur} - 1) + p_{ex}(r_{ex} - 1)]}{[1 + p_{cur}(r_{cur} - 1) + p_{ex}(r_{ex} - 1)]}$$

a = smoking population attributable fraction
Pcur = proportion of current smokers *Pex = proportion of ex-smokers*
Rcur = relative risk for current smokers *Rex = relative risk for ex-smokers*

The data sources were age- and gender-specific prevalence of current- and ex-smoking sourced from the Healthy Ireland Survey[14], combined with international gender-specific relative risks for current and ex-smokers for health conditions where a causal relationship with smoking has been established, **see Table 1**.[7, 15]

Secondly, the PAF for exposure to SHS for never smokers was derived using 2-step formula below:

$$b = \frac{[p_{shs}(r_{shs} - 1)]}{[1 + p_{shs}(r_{shs} - 1)]}$$

and

$$NSB = [T - (T * a)] * [1 - (p_{cur} + p_{ex})]$$

B = Exposure to SHS PAF for each disease
Pshs = Proportion of non-smoking population exposed to SHS
Rshs = Relative risk for people exposed to SHS
NSB =Burden to non-smokers
T = Total number

The data source for exposure of SHS in the home (18%) was sourced from the Healthy Ireland Survey 2016 [16] and combined with internationally-recognised relative risks for non-smokers for health conditions where a causal relationship with exposure to SHS.[7]

Table 1: Relative risk ratios for diseases for current and ex-smokers by gender

Health conditions with a causal relationship with smoking								
	Condition	**ICD-10 Code**	**Age**	**Relative Risks**				**Source**
				Males		**Females**		
				Current	**Ex-smoker**	**Current**	**Ex-smoker**	
CANCERS	Trachea, Bronchus, Lung	C33-C34	35+	23.26	8.70	12.69	4.53	Ref: 15
	Oral and upper respiratory	C00-C14	35+	10.89	3.40	5.08	2.29	Ref: 15
	Oesophageal	C15	35+	6.76	4.46	7.75	2.79	Ref: 15
	Larynx	C32	35+	14.60	6.34	13.02	5.16	Ref: 15
	Stomach	C16	35+	1.96	1.47	1.36	1.32	Ref: 15
	Kidney	C64-C66	35+	2.50	1.70	1.40	1.10	Ref: 15
	Cervical	C53	35+	-	-	1.59	1.14	Ref: 15
	Bladder	C67	35+	3.27	2.09	2.22	1.89	Ref: 15
	Pancreatic	C25	35+	2.31	1.15	2.25	1.55	Ref: 15
	Leukaemia	C91-C96	35+	1.80	1.40	1.20	1.30	Ref: 15
	Liver	C22	35+	1.70	1.40	1.70	1.40	Ref: 7
	Colorectal	C18-C20	35+	2.14	1.47	2.14	1.47	Ref: 7
	Unspecified area	C80	35+	4.40	2.50	2.20	1.30	Ref: 15
CARDIOVASCULAR CONDITIONS	Coronary heart disease (CHD)	I20-I25	35-54	4.2	2.0	5.3	2.6	Ref: 15
			55-64	2.5	1.6	2.8	1.1	Ref: 15
			65-74	1.8	1.3	2.1	1.2	Ref: 15
			75+	1.4	1.1	1.4	1.2	Ref: 15
	Cerebrovascular Disease	I60-I69	35-54	4.4	1.1	5.4	1.3	Ref: 15
			55-64	3.1	1.1	3.7	1.3	Ref: 15
			65-74	2.2	1.1	2.6	1.3	Ref: 15
			75+	1.6	1.1	1.3	1.0	Ref: 15
	Aortic Aneurysm	I71	35+	6.21	3.07	7.07	2.07	Ref: 15
	Atherosclerosis	I70	35+	2.44	1.33	1.83	1.00	Ref: 15
	Other Arterial Disease	I72-I78	35+	2.07	1.01	2.17	1.12	Ref: 15
	Other Heart disease	I00-I09, I26-I51	35+	1.78	1.22	1.49	1.14	Ref: 15
RESPIRATORY CONDITIONS	Chronic obstructive pulmonary disease	J40-43, J47	35+	17.10	15.64	12.04	11.77	Ref: 15
	Chronic airway obstruction	J44	35+	10.58	6.80	13.08	6.78	Ref: 15
	Pneumonia	J12-J18	35-64	2.50	1.40	4.30	1.10	Ref: 15
			65+	2.00	1.40	2.20	1.10	Ref: 15
	Influenza	J10-J11	35-64	2.50	1.40	4.30	1.10	Ref: 15
			65+	2.00	1.40	2.20	1.10	Ref: 15
	Mycobacterium Tuberculosis	A15-A19	35+	2.30	-	2.30	-	Ref: 7
REPRODUCTIVE CONDITIONS	Foetal death and stillbirths	P95, Z37.1, Z37.3, Z37.4, Z37.6, Z37.7	All Ages	-	-	1.47	-	Ref: 7
	Ectopic pregnancy	O00	All Ages	-	-	1.91	-	Ref: 7
	Erectile dysfunction	F52.2, N48.4	20+	1.7	1.6	-	-	Ref: 7
	Oral clefts	Q35-Q37	<1 yr	-	-	1.28	-	Ref: 7
	Perinatal effects	P00.0 - P77 (selection)	All Ages	-	-	1.50	-	Ref: 7
	Low birth weight	P07	<1 yr	-	-	1.40	-	Ref: 7
OTHER CONDITIONS	Cataract	H25	45+	1.54	1.11	1.54	1.11	Ref: 15
	Macular degeneration	H35.3	45+	2.97	1.88	2.97	1.88	Ref: 7
	Hip #	S72.0-S72.2	55-64	1.17	1.02	1.17	1.02	Ref: 15
			65-74	1.41	1.08	1.41	1.08	Ref: 15
			75+	1.76	1.14	1.85	1.22	Ref: 15
	Peptic ulcer disease	K25-K28	35+	5.40	1.80	5.50	1.40	Ref: 15
	Periodontitis	K05.2-K05.6	35+	3.97	1.68	3.97	1.68	Ref: 15
	Diabetes (Type 2)	E11	35+	1.37	1.14	1.37	1.14	Ref: 7
	Rheumatoid arthritis	M05-M06	35+	1.89	1.25	1.75	1.25	Ref: 7
	Dental caries	K02	ALL	*1.76*	*1.39*	*1.76*	*1.39*	Ref: 7
	Crohn's disease	K50	35+	*2.10*	*1.0*	*2.10*	*1.0*	Ref: 15
	Low bone density	M80-M83	45+	-	-	*1.25*	-	Ref: 7

Health conditions with a causal relationship with exposure to second-hand smoke					
	Condition	**ICD-10 Code**	**Age**	**Relative Risk**	**Source**
	Lung (SHS)	C34	20+	1.29	Ref: 7
	CHD (exposure to SHS)	I20-I25	20+	1.32	Ref: 7
	Stroke (exposure to SHS)	I63	20+	1.25	Ref: 7
	SIDS	R95	<1	1.94	Ref: 7
	Middle ear disease (exposure to SHS)	H65-H75	0-10	1.32	Ref: 7
	Low Birth weight (exposure to SHS)	P07	-	1.20	Ref: 7

The smoking PAFs were then applied to observed numbers of in-patients, day cases and associated bed days, by condition, with a primary diagnosis of conditions which can be caused by smoking for the years 2011 to 2016 sourced from the Hospital In-Patient Enquiry System (HIPE).[17] While, the PAF for exposure to SHS for each condition was applied to the non-smoking health burden to estimate the number of hospitalisations due to exposure to SHS.

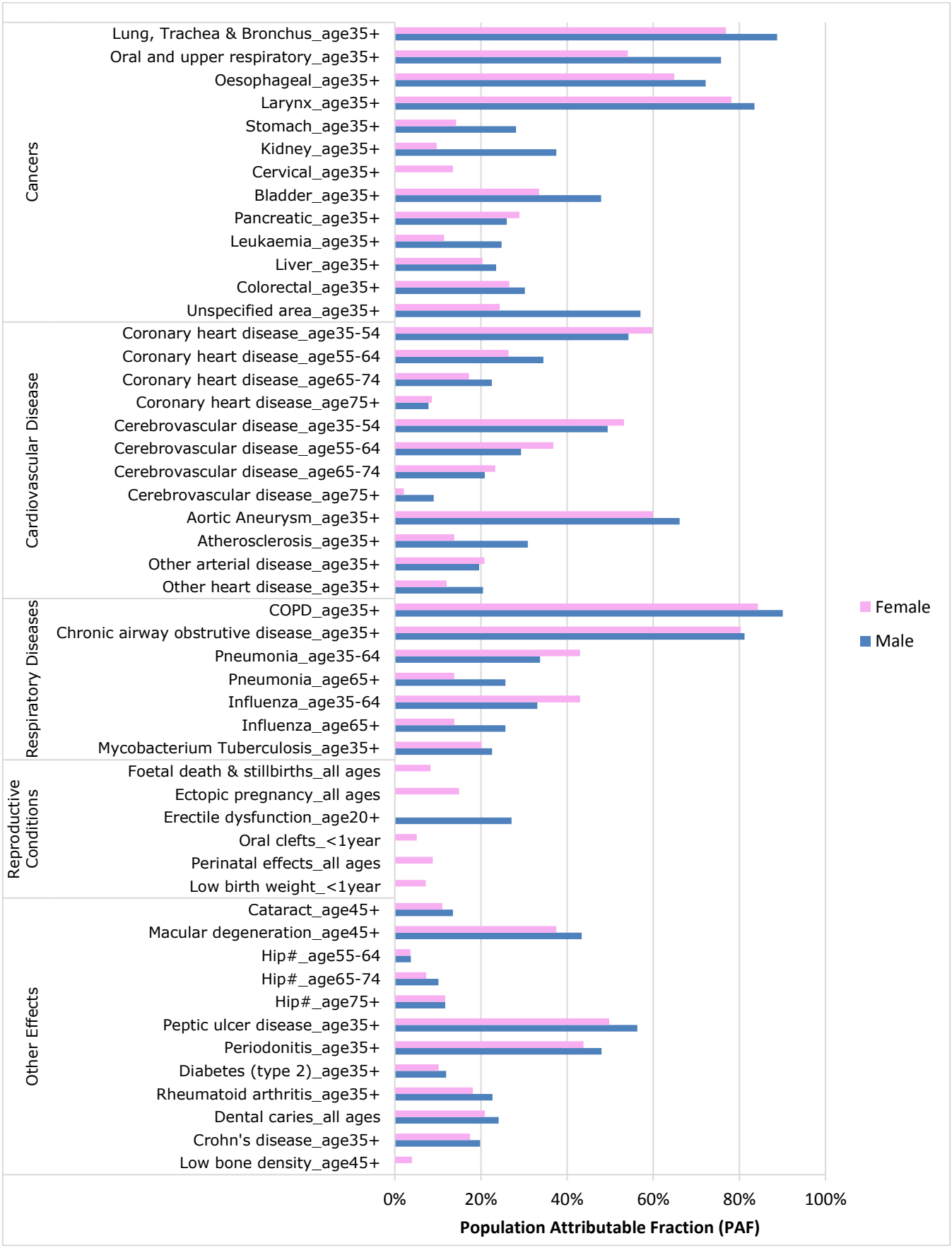
Finally, the average base costs for inpatient and day case admissions for 2016, were sourced from the Healthcare Pricing Office (HPO) through personal communication. These unit costs (inpatient admission = €4,602 and day case admission = €765) were then applied to the estimated numbers of smoking and SHS-attributable hospitalisations and totalled for the year 2016.

All calculations were carried out using Microsoft Excel 2007.

Results

The PAF for all conditions included in this analysis by gender and by disease group, in an Irish setting, are displayed in **Figure 1**. By individual condition, chronic obstructive pulmonary disease (COPD) was the condition with the highest PAF for both males (90.1%) and females (84.3%). Two other conditions had a PAF greater than 80% in males; cancer of the lung, trachea & bronchus (88.8%), and cancer of the larynx (83.5%). There were no additional conditions with a PAF greater than 80% among females. Males had higher PAFs than females for most conditions, with the exception of: Coronary heart disease (35-54 year olds); Cerebrovascular diseases (<75 year olds); Pneumonia (<65 year olds), Influenza (<65 year olds), and pancreatic cancer (35+ year olds). **See Figure 1 (Next page)..**

Figure 1: Irish Population Attributable Fractions for smoking & exposure to SHS, 2015



Sources: HPO and HSE calculations

Applying these PAFs to Irish hospital activity data in 2016, there were an estimated 33,615 inpatient hospital admissions and 21,486 day case admissions attributable to smoking and exposure to SHS in 2016. **See Table 2** Across all hospital activity in these hospitals in 2016, this represents 5% of inpatient admissions and 2% of day case admissions, and resulted in 309,117 bed days (8% of all inpatient bed days in 2016).

Table 2: Hospital activity 2016 for those with a primary diagnosis of diseases which can be caused by smoking and exposure to SHS

Conditions caused by smoking	Inpatient admissions		Day cases		Bed days	
	Male	Female	Male	Female	Male	Female
Cancers	3,713	1,898	5,226	2,614	48,147	23,895
Cardiovascular conditions	6,979	2,749	2,234	815	54,105	23,238
Respiratory conditions	8,105	7,563	585	668	68,086	61,767
Reproductive conditions	<5	849	27	12	11	10,937
Other conditions	682	692	4,432	4,661	6,997	8,267
Total (Smoking)	19,481	13,751	12,504	8,770	177,346	128,104
Conditions caused by exposure to SHS	Inpatient admissions		Day cases		Bed days	
	Male	Female	Male	Female	Male	Female
Lung Cancer	4	7	4	10	41	79
Coronary heart disease	150	73	71	37	776	395
Stroke	40	39	0	0	671	708
Middle ear disease	13	10	54	36	24	19
Low birth weight	0	49	0	0	0	955
Total (SHS)	207	178	129	83	1,512	2,156
TOTAL (Smoking & SHS)	Inpatient admissions		Day cases		Bed days	
	33,615		21,486		309,117	

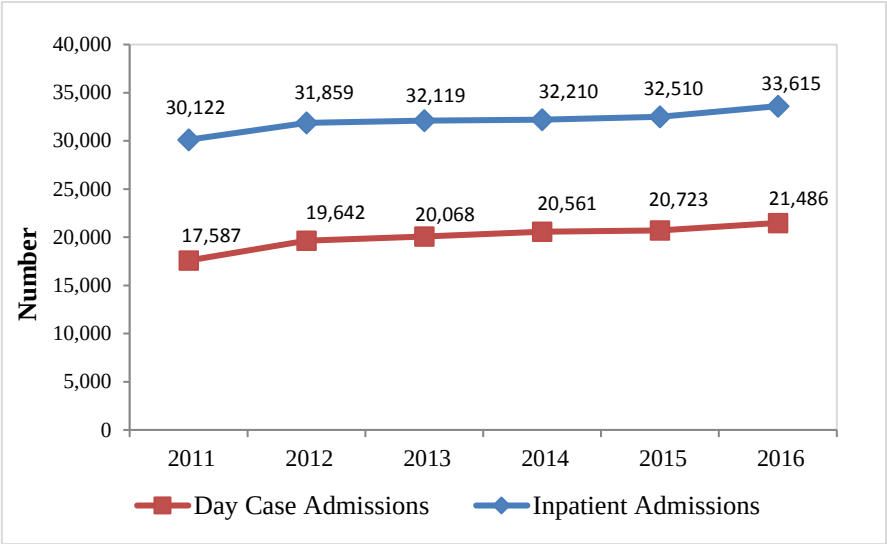
Sources: HPO and HSE calculations

Table 2 details these smoking and SHS-related hospitalisations in 2016 by gender and disease group. Almost 60% of both these inpatient admissions (n=19,688) and day case admissions (n=12,633) were by males. Overall, the burden of smoking and SHS-related hospitalisation is greater for males than females, with 7% of all hospitalisations among males estimated to be smoking or SHS-related, compared to 4% among females.

Further analysis of these hospitalisations revealed that respiratory conditions (47%, n=15,668) were the most common reason for smoking-related inpatient hospitalisation in 2016 followed by cardiovascular conditions (29%, n=9,728) and cancers (17%, n=5,611). 'Other conditions' (43%, n=9,093) were the main reason for smoking-related day case admission, followed by cancers (37%, n=7,840) and cardiovascular conditions (14%, n=3,049). Coronary heart disease was the most common reason for SHS-related inpatient hospitalisation (58%, n=223) and SHS-related day case admission (51%, n=108). Using the estimates in **Table 2**, almost one-in-five inpatient admissions for all respiratory diseases, circulatory diseases and cancers in 2016, were estimated to be attributable to smoking and SHS.

Figure 2 displays the trend in inpatient and day case admissions attributable to smoking and exposure to SHS from 2011-2016; the number of these admissions increased by 13% (9% increase in all inpatient activity) and 22% (20% across all day case activity), respectively, as displayed in **Figure 2**. However, tests for trends revealed that these increases were not significantly different to increases in overall hospital activity for the same period. Compared to 2011, the number of smoking-related inpatient bed days decreased marginally by <1% in 2016.

Figure 2: Estimated number of hospital admissions with a primary diagnosis of diseases which can be attributable to smoking and exposure to SHS, 2011-2016.



Sources: HPO, HSE

Finally, using the average base costs in 2016, the estimated direct cost of smoking & SHS-related hospitalisations detailed in this analysis was €171.5 million in 2016.

Discussion

This study presents an up-to-date estimate of the burden of smoking and SHS-related hospitalisations in Ireland to 2016; the number of hospitalisations increased yearly, as did all hospital activity, and in 2016 there were an estimated 33,600 inpatient admissions and 21,500 day case admissions at a total cost (direct) of approximately €171.5 million. It must be noted that this is an under-estimate due to the exclusion of outpatient clinic attendances or emergency department presentations, and this analysis also only documents those admissions with a primary diagnosis of the disease; many of these patients are on a long journey to recovery, for example, cancer patients, and will have several more hospital encounters for treatment etc, however for comparison reasons, this analysis detailed primary diagnosis only. Nevertheless, for a health system that is currently experiencing many challenges regarding capacity, waiting times and waiting lists, the fact that this many hospitalisations are potentially preventable is certainly food for thought!

In 2018, 20% of Irish adults smoke, with high smoking rates among young people; this compares favourably to a smoking prevalence of 29% in 2007 [3,18]. And, while smoking prevalence is falling and will continue to, in the attempt to achieve a smoke-free Ireland by 2025, many people will continue to live with the health effects of their smoking into the future. A recent Irish study detailed the impact of smoking on the health of older Irish adults: those who smoked self-reported poorer physical and mental health, and considered their own health to be worse than their peers; In addition, the prevalence of self-reported smoking-related chronic diseases was highest among ex-smokers, and the extent of this ill-health was related to the amount smoked.[19] Quitting smoking results in many physical and mental health gains; specifically, reduced risk of death from cardiovascular disease and COPD, and stopping smoking before age 40 reverts life expectancy close to that of non-smokers.[20] So, in order to maximise the benefits of quitting smoking, smokers must quit at a younger age.

An interesting finding of this study is the greater burden of smoking-related disease for males, with almost 50% more hospitalisations by males compared to females. The recent State of Tobacco Control in Ireland report detailed how the impact of tobacco in Ireland is different for males in Ireland, with differences in smoking behaviour, the use of smoking cessation services, and the burden of smoking-related disease and death.[2] Irish males smoke more than Irish females (22% versus 17%), however, quitting intentionality, and the proportion of quit attempts among males is similar to female rates.[3]

Successfully quitting smoking is difficult, and currently the majority of smokers attempting to quit choose to use no supports (42%), or use e-cigarettes (41%) in their quit attempt.[3] Research indicates that smokers are twice as likely to quit if they engage with a smoking cessation service, such as the HSE QUIT service (a team of advisors available to

smokers over the phone, by email, online, or in person), and they are four times more likely to quit if they also use smoking cessation medications, such as varenicline, bupropion and nicotine replacement therapy.[21] Internationally, a large body of evidence supports the delivery of smoking cessation interventions in all healthcare encounters.[22-24] Currently in Ireland, national clinical guidelines for the identification and treatment of tobacco addiction are in development and have been approved for prioritisation by the Department of Health's National Clinical Effectiveness Committee (NCEC). This guideline will utilise the Department of Health commissioned Health Technology Assessment (HTA) of smoking cessation treatments available in Ireland by the Health Information & Quality Authority (HIQA), [21] as well as other International guidelines on smoking cessation, with planned publication of the guideline in late 2019. Evidence-based smoking cessation is key to Ireland becoming tobacco-free by 2025.

Winning the war on tobacco is a long game, and for health policy-makers and planners, continued focus on this area competes with other priorities. Regular reporting of the burden of ill-health due to amenable risk factors, highlighting the impact on health services and costs, can be an important way of sustaining engagement.[25] The utilisation of PAF methodology allows for comparisons internationally and provides robustness to the evidence; the automation of such analysis would allow for more routine, timely reporting.

Some limitations to this study were noted by the authors: Firstly, only those conditions with a causal relationship with smoking and exposure to SHS were included; secondly, attendances at outpatient clinics and emergency departments were excluded as there are no reporting systems, and thirdly, only hospital admissions with a primary diagnosis of these conditions was reported in this analysis; this is as per the methodology for this type of analysis, and for comparison reasons, it is necessary to follow the same methodology as other organisations, internationally.

In conclusion, almost 1,000 hospital episodes each week in Irish hospitals are attributable to smoking and exposure to SHS; with one-in-five admissions for respiratory diseases, circulatory diseases, and cancers potentially preventable. This analysis highlights the impact of tobacco on Irish adults, especially males. For the health services, this analysis highlights the potential savings if Ireland was tobacco-free and the significant opportunities to engage with smokers with evidence-based smoking cessation.

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Declaration of Conflicts of Interest:
The authors have no conflicts of interest to declare.

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References:

1. World Health Organization. WHO report on the Global Tobacco Epidemic 2017: Monitoring Tobacco Use & Prevention Policies. ISBN 978-92-4-151282-4. World Health Organization. 2017.
2. Tobacco Free Ireland Programme, HSE. The State of Tobacco Control in Ireland. Health Service Executive (HSE) 2018.
3. Department of Health & IPSOS MRBI. Healthy Ireland Survey 2018 – Summary of Findings. Dublin, 2018.
4. Department of Health. Tobacco Free Ireland – Report of the Tobacco Policy Review Group. Department of Health, Dublin, 2013.
5. U.S. Dept. of Health, Education, and Welfare, Public Health Service. Smoking and health: Report of the advisory committee to the Surgeon General of the Public Health Service. Washington, US. 1964.
6. Doll R, Hill AB. Smoking and carcinoma of the lung. BMJ 1950; 221(ii): 739–48.
7. US Department of Health and Human Services. The Health Consequences of Smoking: 50 Years of Progress. A Report of the Surgeon General. Atlanta, GA: US Department of Health and Human Services, Centre for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2014.

8. Mansournia Mohammad Ali, Altman Douglas G. Population attributable fraction BMJ 2018; 360 :k757
9. NHS Digital. Statistics on Smoking - England 2018. https://files.digital.nhs.uk/0C/95F481/stat-smok-eng-2018-rep.pdf
10. Public Health England. Local Tobacco Control Profiles for England. 2018. https://fingertips.phe.org.uk/profile/tobacco-control
11. Rothman KJ, Greenland S, Lash T. Measures of effect and measures of association. In:Rothman KJ, Greenland S, Lash T, eds. Modern epidemiology.3rd ed. Lippincott Williams & Wilkins, 2008: 51-70
12. Greenland S. Concepts and pitfalls in measuring and interpreting attributable fractions, prevented fractions, and causation probabilities. Ann Epidemiol2015;25:155-61
13. ICF International for the Department of Health. An Assessment of the Economic Cost of Smoking in Ireland. Dublin, 2015.
14. Department of Health & IPSOS MRBI. Healthy Ireland Survey 2015 – Summary of Findings. Dublin, 2015.
15. The Health & Social Care Information Centre (HSCIC), 2014, Statistics on Smoking 2014.
16. Department of Health & IPSOS MRBI. Healthy Ireland Survey 2016 – Summary of Findings. Dublin, 2016.
17. Healthcare Pricing Office. HIPE data accessed via HIPE Online Portal.
18. SLAN 2007 - Survey of Lifestyle, Attitudes & Nutrition in Ireland, Department of Health & Children. 2008.
19. Sheridan A, O'Farrell A, Evans D.S., Kavanagh P. Adult Smoking in Ireland: A Special Analysis of the Healthy Ireland Survey and the Irish Longitudinal Study on Ageing (TILDA). Health Service Executive May 2018. (978-1-898098-83-6)
20. Quick Wins: the short-term benefits of stopping smoking. The National Centre for Smoking Cessation & Training. 2013. http://www.ncsct.co.uk/usr/pub/Quick%20_wins_full_report.pdf
21. HIQA. Health Technology Assessment (HTA) of smoking cessation interventions. Dublin. 2017.
22. NICE (2018) NG92 Stop smoking interventions and services. Available from www.nice.org.uk/guidance/ng92
23. Ministry of Health. 2014. The New Zealand Guidelines for Helping People to Stop Smoking. Wellington: Ministry of Health
24. European Network for Smoking and Tobacco Prevention (ENSP). Guidelines for Treating Tobacco Dependence. Belgium. March 2016.
25. Elliott H, Popay J: How are policy makers using evidence? Models of research utilisation and local NHS policy making. *J Epidemiol Community Health* 2000, 54:461-468.