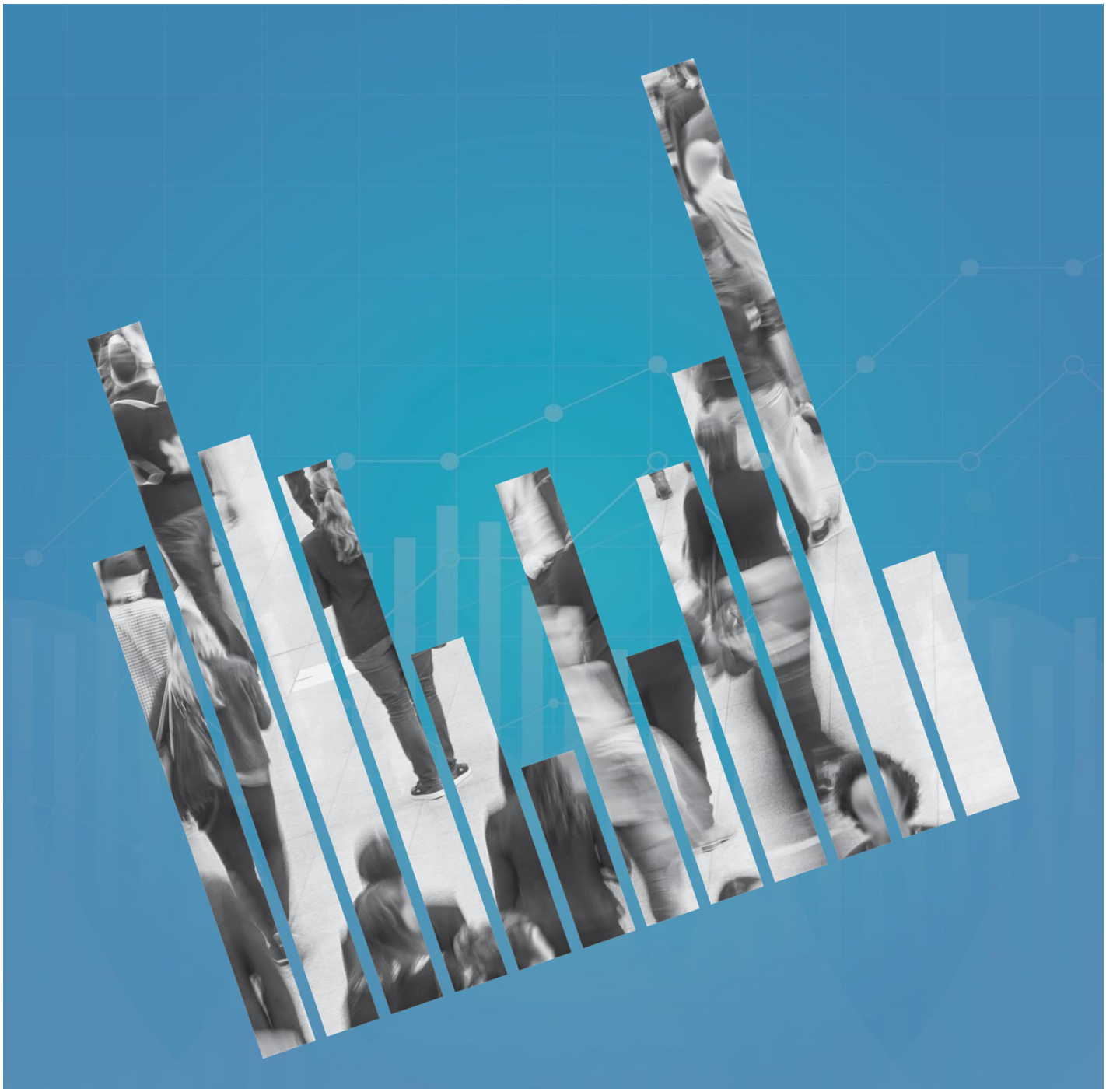
ESTIMATES OF THE HEALTH SERVICE COSTS OF CANCERS ASSOCIATED WITH SMOKING, OVERWEIGHT AND OBESITY, AND ALCOHOL INTAKE IN IRELAND DURING 2016

National Cancer Registry Ireland



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REPORT AT A GLANCE

Estimates of the health service costs of cancers associated with smoking, overweight and obesity, and alcohol intake in Ireland, 2016.

Who are we, and what do we do?

The National Cancer Registry of Ireland (NCRI) works on behalf of the Department of Health and collects information from all hospitals in Ireland on the number of persons diagnosed with cancer and the types of cancer they have.

NCRI also follows up the numbers dying from their cancer or from other causes. This allows the monitoring of trends and outcomes in different cancer types, which in turn assists with the planning and management of services. All the patient's personal and private details are removed before summaries of this information are made available to the public and health professionals through our annual cancer report and other reports on our website.

How are the numbers reported?

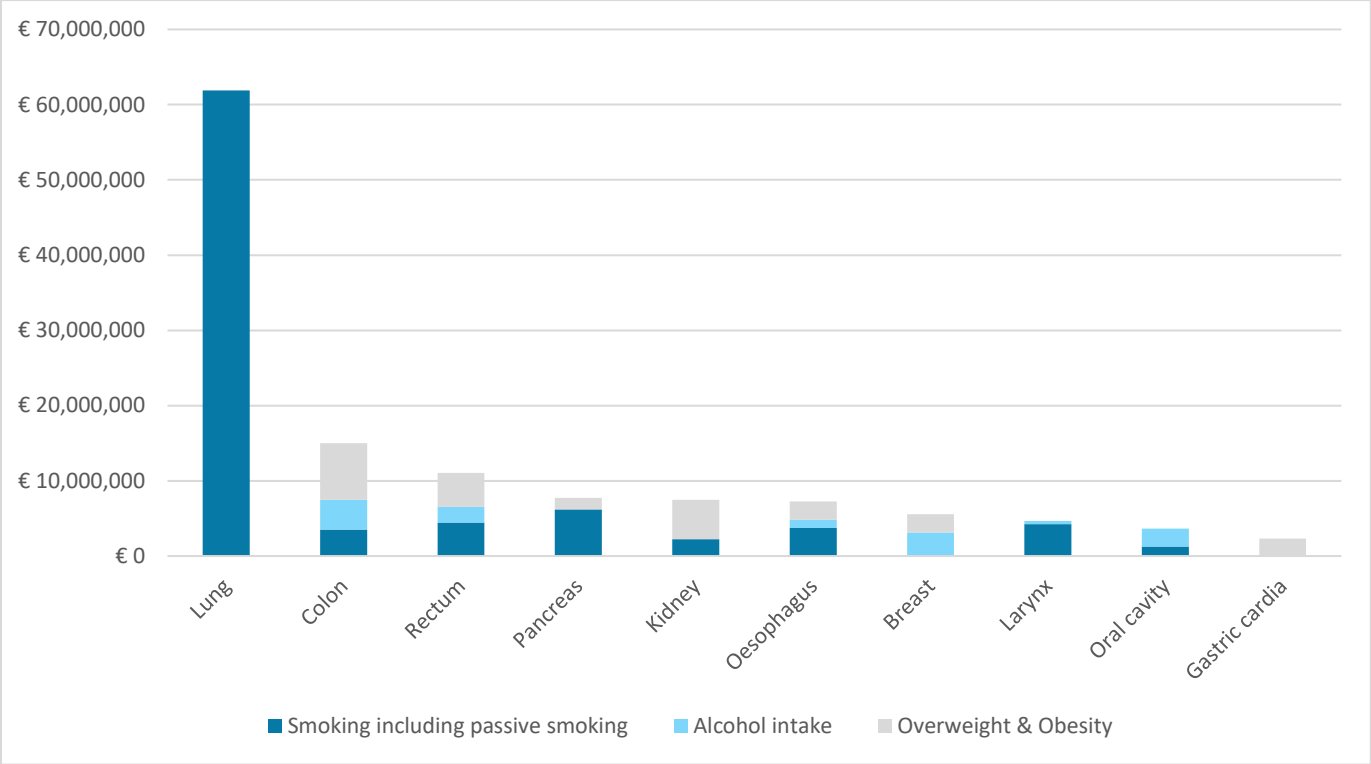
NCRI data on the number of cancer cases in 2016 was utilised for this report. Data were also collected from a variety of sources to determine both the extent to which the Irish population are exposed to modifiable risk factors, including smoking (including passive smoking in the home), overweight and obesity, and alcohol intake, and the likelihood of being diagnosed from cancer as a result of the exposure. All of this information was inputted to formulae to calculate the percentages and numbers of 2016 cancer cases attributable to each risk factor. See the NCRI 2020 report on "Modifiable risk factors and cancer in Ireland" for further details on this.

Previously estimated health service costs per cancer case were obtained from existing studies. The estimated average cost per case was multiplied by the number of cancer cases attributable to smoking, overweight and obesity, and alcohol consumption in 2016 to estimate the total healthcare cost of cancers attributable to these risk factors.

What have we found?

The estimated health service cost of cancer in Ireland in 2016 attributable to smoking, alcohol intake and overweight and obesity was €140 million. Over €95 million was estimated to be attributable to smoking. Lung cancer was the cancer type with the highest cost attributable to modifiable risk factors in Ireland with a total of €62 million, all of which was attributable to smoking. See *Figure 1* for details of the 10 cancer types with highest estimated health service costs attributable to smoking, alcohol intake, overweight and obesity. It should be emphasised that these costs are underestimates of total costs; they include health service costs only and do not reflect the many other economic and societal impacts of cancer. For this reason, and because these estimates use a variety of sources for costings, further research is warranted on the total costs of potentially preventable cancer in Ireland.

Fig 1. Cost by cancer type (diagnosed in 2016); the ten cancer types with highest estimated health service costs attributable to smoking, alcohol intake, overweight and obesity.



1. BACKGROUND

- The Agency for Healthcare Research and Quality estimated that the direct costs of cancer in the United States alone amounted to more than $80 billion in 2015, with a large part of this being attributable to cancer-directed treatment (www.meps.ahrq.gov/mepsweb/ via www.cancer.org).
- A European analysis of the economic burden of cancer put the overall cost of the disease at €126 billion annually (for 2009), with health service costs accounting for some €51 billion of this (1).
- The costs of managing the disease are rising, with increased oncology costs, even for older medicines, being recorded (2,3). This means that, as populations age and incidence and survival increase, worldwide, health systems face a large and growing problem of financing and planning cancer care now and into the future (4).
- The costs to patients, their families and wider society are significant too. Marti and colleagues (5) from the United Kingdom estimated an average monthly societal cost of cancer of £260 per case. This broke down as costs to the health service (NHS) of £177, patient out-of-pocket costs (OOPCs) of £25 and informal care costs of £70 (means). A report by the Macmillan charity (6) found that over 80% of cancer survivors were incurring costs of approximately £570 each month after their diagnosis with most of this comprising forgone income and OOPCs. The Irish Cancer Society reported on "The real cost of cancer" in 2019 and estimated that the average cost to someone dealing with cancer is €756 a month (7).
- Data on cancer incidence in Ireland are collected and reported by the National Cancer Registry (NCRI), and NCRI has recently used this data, in combination with available quantitative data on cancer risk factors, to estimate the numbers of cancers attributable to potentially modifiable risk factors (8).
- For 2016, this estimate amounted to 6,200 newly diagnosed cancers (or 29% of all cancers excluding non-melanoma skin cancers) being attributable to the 11 specific risk factors examined. Most strikingly, tobacco smoking (including exposure to passive smoking in the home) accounted for an estimated 2,800 cases (13% of all cancers) and high body mass index (BMI) for 1,000 cases (5% of all cancer) in 2016. These two factors plus alcohol consumption accounted, in combination, for an estimated 4600 cases, or 22% of all cancers (8). This report also included projections of cancer cases attributable to these three risk factors in 2035.
- The present report seeks to estimate the annual cost of cancers to the healthcare system that are attributable to smoking, high BMI, or alcohol consumption in Ireland, to provide a fuller assessment of the impact of these risk factors in terms of potentially preventable cancers
- While international estimates are available, data concerning the costs of cancer in Ireland remains limited. Some work has provided estimates for particular cancer sites, but for many others information on the costs of cancer as they fall on the health system, patients and their families and society at large is absent. Consequently, we conducted a review of the international published literature to identify treatment cost estimates that might be usefully employed as proxies for Irish cost data.

2. METHODOLOGY

- Health service costs are the costs incurred by the healthcare systems or third party payers (insurance companies). These costs include the actual costs of providing services related to the delivery of health care, including the costs of procedures, therapies and medications. Analyses here do not include the many personal costs associated with a cancer diagnosis including travel /arrangements relating to appointments, the impact on day-to-day living costs, one-off expenses and the impact on income.
- Previously estimated healthcare service costs per cancer case were obtained from existing studies. As per Orenstein et al. (9), the estimated average cost per case was multiplied by the number of cancer cases attributable to smoking (including exposure to passive smoking in the home), overweight and obesity, and alcohol consumption (as previously calculated for Ireland (8)) to calculate the total healthcare service cost of cancers attributable to these risk factors.
- Existing studies were reviewed to establish health service costs. We interrogated the PubMed research database in April 2020 using MeSH headings for each disease site in combination with MeSH terms relating to economic evaluations (see *Appendix 1* for a comprehensive list of search terms).
- In line with the practice in other reviews, we limited our search to studies published in the last ten years as costing exercises from earlier than this likely reflect more historic treatment modalities, social conditions, and cost trends.
- Only studies based on costs for WHO Very High Health Index countries were eligible for inclusion as care provision and the experience of cancer are likely to differ importantly outside of this group.
- We did not include costs from cost-effectiveness studies as these are unlikely to reflect costs as they arise at the population care level
- Details of the included papers for each site can be found in *Appendix 2*. The included papers are from a range of settings including Ireland (10), France (11), the United Kingdom (12), the United States (13), and Canada (14).
- Our analysis reflects costs as they arise in the period relating to initial diagnosis and treatment – typically up to between six months and a year post-diagnosis. For most cancers, this will cover the vast majority of costs incurred for cancer-directed management. For some conditions however, in particular haematological malignancies or other cancers where disease relapse or recurrence is more prevalent, this cost approach may mean that the cost of a typical case is underestimated.
- Arising from the lack of data specific to Ireland, the cost estimates employed are mainly from other western countries including France, the United Kingdom, the United States and Canada. These countries all have different health systems (though all have some mix of public and private care) and the studies themselves differed in how they measured cost to some degree. While we attempted to select estimates that were likely comparable with those that might apply in an Irish setting, care should be taken in the interpretation of our figures for Ireland.
- All costs were converted to Euro (where they were not already denominated in Euro) using the average annual exchange rate as published by the European Central Bank and adjusted to 2016 terms using the Health index of the CPI as published by the Central Statistics Office.
- An assumption of this methodology is that the cost of a typical cancer is the same between those cancers that arise from the assessed risk factors and all other cancers. It is possible that this might not be so and that the costs of a cancer arising from a specific risk factor might be more costly to manage.
- A further assumption is that costs for a given cancer type relate to the 'average' distribution of cases by stage or other prognostic factors for that cancer, in the source study, with a similar distribution assumed to apply in an Irish setting.

3. RESULTS & CONCLUSIONS

Summary of results

- The total estimated health service cost of cancer in Ireland in 2016 attributable to smoking, alcohol intake and overweight and obesity was €140 million.
  - €95 million was estimated to be attributable to smoking
  - €31 million was estimated to be attributable to overweight and obesity
  - €14 million was estimated to be attributable to alcohol intake.
- Lung cancer was the cancer type with the highest cost attributable to modifiable risk factors in Ireland with a total of €62 million, all of which was attributable to smoking.
- The cost of cancer attributable to smoking, alcohol intake, overweight and obesity was higher in males (€80 million) compared to females (€60 million). See *Tables 3.1* and *3.2* for male and female breakdown of costs.
- In males, lung, colon and rectal cancer were the three cancer types, attributable to modifiable risk factors, with the highest health service costs (*Table 3.1*).
- In females, lung, colon and pancreas cancer were the three cancer types, attributable to modifiable risk factors, with the highest health service costs (*Table 3.2*).
- See *Figure 3.1* for a summary of the ten cancer types with highest costs attributable to smoking, alcohol intake, overweight and obesity in 2016.

Considerations, strengths and limitations

- Enhanced understanding of the cost associated with cancer can inform policies to reduce exposure to modifiable risk factors. The cost of cancers can be estimated from the individual, family, employer, government, and societal perspectives. This analysis examines the health service cost of cancers associated with smoking (including exposure to passive smoking in the home), alcohol intake, overweight and obesity to in Ireland.
- This analysis builds upon work that was carried out at the NCRI on the fraction of cancer attributable to modifiable risk factors including smoking, alcohol intake and overweight and obesity (see https://www.ncri.ie/publications/statistical-reports/modifiable-risk-factors-and-cancer-ireland)
- The estimates of the economic burden of these cancers were limited by limited availability of data. Due to a paucity of data from Ireland on the health service cost of different cancer types, this analysis relied heavily on reviewing literature from other, broadly comparable countries.
- These are only estimated healthcare service costs and do not include the many other costs associated with a cancer diagnosis, including costs associated with appointments, the impact on day-to-day living costs, one-off expenses, and the impact on income. See the Irish Cancer Society report on “The real cost of cancer” for further details (7). That report estimated that the average cost to someone dealing with cancer is €756 a month.
- It needs to be emphasised that the costings for different cancer types in this analysis have been collated from multiple sources (and include different

countries, different timeframes for original costings etc.). Therefore, even with adjustments made to provide costings appropriate to 2016, these estimates are rough approximations and detailed comparison across cancer sites is not recommended. See *Appendix 2* for sources of costings.

- It is important to note that the costs in this analysis are based on cancer-related expenditures from the last ten years. Many malignancies will have acquired new (typically much more expensive) treatments and increased survival even within this period, and 'current' treatment costs may be underestimated as a result.
- As many of the costs associated with cancer treatment continue to increase, future costs associated with cancers relating to modifiable lifestyle risk factors are likely to increase dramatically. This reflects both the component costs of medicines and diagnostics rising, and these interventions being required for longer as patient survival duration increases. Medical inflation will also push up these costs. Public health policies and interventions to help prevent these cancers will thus be even more crucial.
- The sources of medical costs used here include a mix of costings from different 'windows' following cancer diagnosis, which contributes to the variability of estimates. For example, some costings are attributed to the first six to twelve months post-diagnosis or post-surgery while others are based on the annual average prevalent cost (i.e. including further cancer-associated healthcare service costs among survivors). See *Appendix 2* for details.

Conclusion and recommendations

- Given much of the data is from the EU (which has similar treatment costs to Ireland) but is based on short-term treatment costs, findings in this report are best considered as lower-level estimates. Therefore, we conclude that, in terms of cancer health service costs alone, these three risk factors cost Ireland at least €140m in 2016.
- It is recommended that the findings in this report be used to support and inform future health-related policy planning. It is important that there is an emphasis on the prevention of cancer in relation to modifiable risk factors including smoking, overweight and obesity and alcohol intake. The estimated costs reported here reflect only one aspect of the overall treatment costs; these modifiable risk factors are associated with a range of other diseases also and this has not been considered in this analysis. Investment in public health policies which reduce the impact of modifiable risk factors of ill-health can greatly benefit individuals in our community and reduce the economic costs and other burdens of ill-health for our society.

Fig 3.1. Cost by cancer type (diagnosed in 2016); the ten cancer types with highest estimated health service costs attributable to smoking, alcohol intake, overweight and obesity.

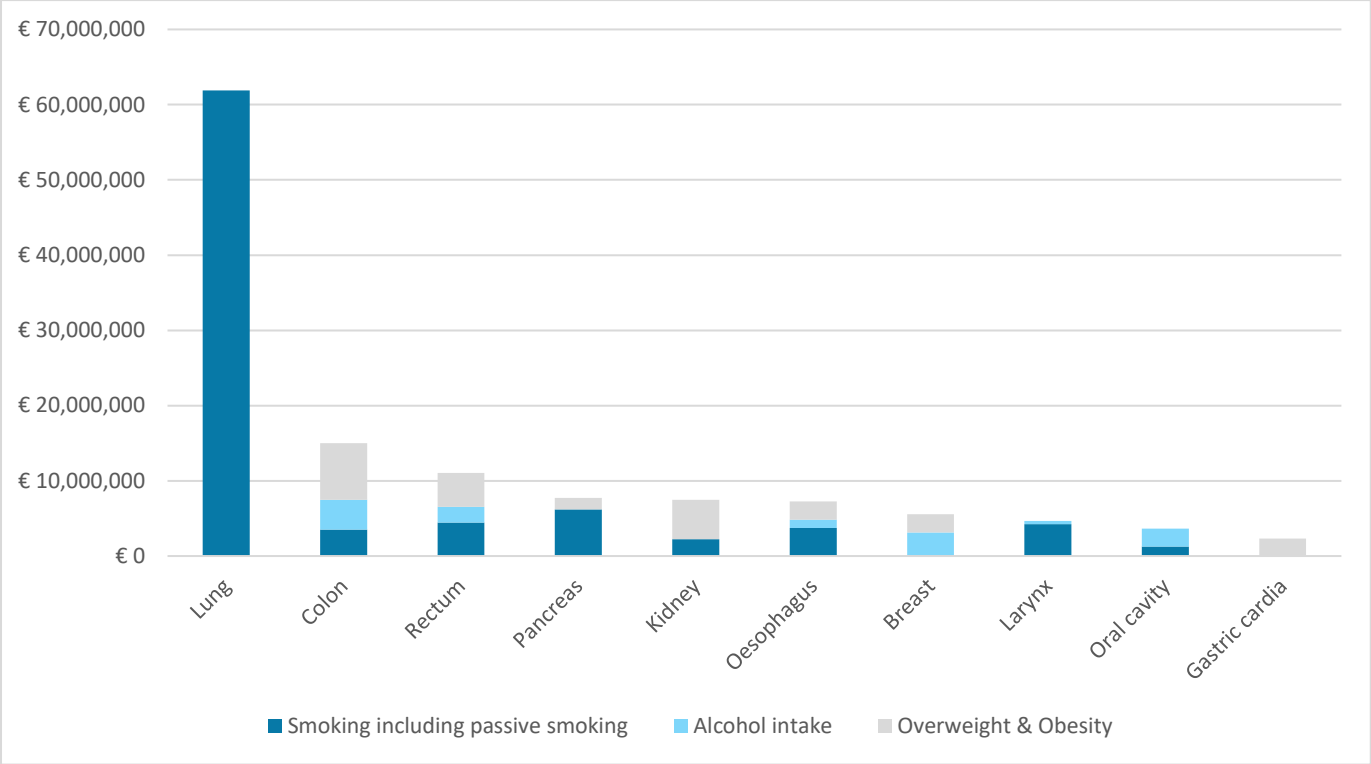


Table 3.1. Male costs per cancer, and costs of male cancers in 2016, attributable to smoking, overweight and obesity, and alcohol consumption.

Cancer site	*Cost	*Cost of cancers diagnosed in 2016 attributable to:			
	per case	Smoking (incl. passive smoking)	Alcohol intake	Overweight & Obesity	smoking, alcohol, overweight & obesity
Oral cavity	€31,910	€702,276	€2,014,224	€0	€2,716,499
Pharynx	€19,927	€821,648	€445,325	€0	€1,266,973
Nasopharynx	€14,143	€52,765	€0	€0	€52,765
Oesophagus_ac[a]	€29,261	€791,249	€0	€1,855,244	€2,646,493
Oesophagus_scc[b]	€29,261	€1,623,552	€704,555	€0	€2,328,107
Stomach	€64,276	€1,842,723	€0	€0	€1,842,723
Gastric cardia	€64,276	€0	€0	€1,798,480	€1,798,480
Brain and CNS	€100,708	€0	€0	€0	€0
Colon	€41,391	€1,914,777	€2,817,287	€5,480,663	€10,212,727
Rectum	€48,122	€2,964,264	€1,698,370	€3,801,063	€8,463,698
Liver	€16,098	€649,085	€100,802	€492,154	€1,242,041
Gallbladder	€14,143	€0	€0	€35,697	€35,697
Pancreas	€50,172	€3,231,450	€0	€886,198	€4,117,647
Larynx	€38,722	€3,652,927	€411,541	€0	€4,064,468
Lung	€35,480	€32,487,663	€0	€0	€32,487,663
Kidney	€33,600	€1,537,970	€0	€2,898,207	€4,436,176
Bladder	€9,515	€1,411,953	€0	€0	€1,421,468
Thyroid	€6,701	€0	€0	€43,756	€43,756
Myeloma	€18,233	€0	€0	€428,612	€428,612
Acute myeloid leukaemia	€30,453	€208,229	€0	€0	€208,229
Totals		**€53,892,531**	**€8,192,104**	**€17,720,072**	**€79,814,221**

*Health service costs

[a,b]Oesophageal cancer subtypes: [a]adenocarcinoma, [b]squamous cell carcinoma

Table 3.2. Female costs per cancer, and costs of female cancers in 2016, attributable to smoking, overweight and obesity, and alcohol consumption.

Cancer type	*Cost	*Cost of cancers diagnosed in 2016 attributable to:			
	per case	Smoking (incl. passive smoking)	Alcohol intake	Overweight & Obesity	Smoking, alcohol, overweight & obesity
Oral cavity	€31,910	€545,615	€394,912	€0	€940,527
Pharynx	€19,927	€253,667	€68,756	€0	€322,423
Nasopharynx	€14,143	€20,576	€0	€0	€20,576
Oesophagus_ac[a]	€29,261	€254,166	€0	€595,884	€850,049
Oesophagus_scc[b]	€29,261	€1,067,842	€375,163	€0	€1,443,005
Stomach	€64,276	€207,071	€0	€0	€207,071
Gastric cardia	€64,276	€0	€0	€531,085	€531,085
Brain & CNS	€100,708	€0	€0	€298,986	€298,986
Colon	€41,391	€1,600,399	€1,156,319	€2,054,016	€4,810,733
Rectum	€48,122	€1,474,341	€406,271	€683,834	€2,564,446
Liver	€16,098	€206,441	€5,591	€305,725	€517,757
Gallbladder	€14,143	€0	€0	€134,354	€134,354
Pancreas	€50,172	€2,979,744	€0	€623,768	€3,603,512
Larynx	€38,722	€576,329	€34,272	€0	€610,601
Lung	€35,480	€29,423,520	€0	€0	€29,423,520
Breast	€14,900	€0	€3,143,324	€0	€3,143,324
Breast (Postmenopausal)[c]	€14,900	€0	€0	€2,424,005	€2,424,005
Cervix	€18,388	€1,095,941	€0	€0	€1,095,941
Uterus	€9,094	€0	€0	€1,627,194	€1,627,194
Ovary	€62,253	€0	€0	€1,102,979	€1,102,979
Mucinous ovarian	€62,253	€128,954	€0	€0	€128,954
Kidney	€33,600	€718,595	€0	€2,306,713	€3,025,308
Bladder	€9,515	€497,360	€0	€0	€497,360
Thyroid	€6,701	€0	€0	€109,699	€109,699
Myeloma	€18,233	€0	€0	€195,316	€195,316
Acute myeloid leukaemia	€30,453	€165,493	€0	€0	€165,493
Totals		**€41,216,054**	**€5,584,608**	**€12,993,554**	**€59,794,216**

*Health service costs

[a,b]Oesophageal cancer subtypes: [a]adenocarcinoma, [b]squamous cell carcinoma. [c]Post-menopausal breast cancer only for overweight and obesity.

Table 3.3. Costs per cancer, and total costs of cancers in 2016 (male and female), attributable to smoking, overweight and obesity, and alcohol consumption.

Cancer type	*Cost	*Cost of cancers diagnosed in 2016 attributable to:			
	per case	Smoking including passive smoking	Alcohol intake	Overweight & Obesity	Smoking, alcohol, overweight & obesity
Oral cavity	€31,910	€1,247,891	€2,409,136	€0	€3,657,027
Pharynx	€19,927	€1,075,315	€514,081	€0	€1,589,395
Nasopharynx	€14,143	€73,342	€0	€0	€73,342
Oesophagus_ac	€29,261	€1,045,415	€0	€2,451,127	€3,496,542
Oesophagus_scc	€29,261	€2,691,394	€1,079,718	€0	€3,771,112
Stomach	€64,276	€2,049,794	€0	€0	€2,049,794
Gastric cardia	€64,276	€0	€0	€2,329,565	€2,329,565
Brain and CNS	€100,708	€0	€0	€298,986	€298,986
Colon	€41,391	€3,515,176	€3,973,606	€7,534,678	€15,023,461
Rectum	€48,122	€4,438,605	€2,104,642	€4,484,897	€11,028,144
Liver	€16,098	€855,526	€106,393	€797,878	€1,759,797
Gallbladder	€14,143	€0	€0	€170,051	€170,051
Pancreas	€50,172	€6,211,193	€0	€1,509,966	€7,721,159
Larynx	€38,722	€4,229,256	€445,813	€0	€4,675,069
Lung	€35,480	€61,911,183	€0	€0	€61,911,183
Breast	€14,900	€0	€3,143,324	€0	€3,143,324
Breast (postmenopausal)[c]	€14,900	€0	€0	€2,424,005	€2,424,005
Cervix	€18,388	€1,095,941	€0	€0	€1,095,941
Uterus	€9,094	€0	€0	€1,627,194	€1,627,194
Ovary	€62,253	€0	€0	€1,102,979	€1,102,979
Mucinous ovarian	€62,253	€128,954	€0	€0	€128,954
Kidney	€33,600	€2,256,565	€0	€5,204,920	€7,461,484
Bladder	€9,515	€1,909,313	€0	€0	€1,918,828
Thyroid	€6,701	€0	€0	€153,455	€153,455
Myeloma	€18,233	€0	€0	€623,927	€623,927
Acute myeloid leukaemia	€30,453	€373,722	€0	€0	€373,722
Totals		**€95,108,583**	**€13,776,712**	**€30,713,627**	**€139,608,437**

*Health service costs

[a,b]Oesophageal cancer subtypes: [a]adenocarcinoma, [b]squamous cell carcinoma. [c]Post-menopausal breast cancer only for overweight and obesity

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APPENDIX I: SEARCH TERMS

Population attributable fractions & health service cost analysis; literature searching per cancer site

Cancers to cover; those relating to smoking, alcohol and obesity/overweight.

- Oral cavity
- Larynx
- Oesophagus
- Lung
- Pancreas
- Sino-nasal
- Nasopharynx
- Pharynx
- Liver
- Stomach
- Colon
- Rectal
- Kidney
- Leukaemia
- Breast
- Ovary
- Uterus
- Myeloma
- Brain and CNS
- Thyroid
- Gallbladder

Search terms;

(((costs and cost analysis[MeSH Terms]) OR (allocation, cost[MeSH Terms])) OR (cost apportionment[MeSH Terms])) AND (2010:2020[pdat])) AND (Cost*[Title])) NOT (cost-effective*[Title])) NOT (cost-utility)

APPENDIX 2: HEALTH SERVICE COSTS PER CANCER SITE

Health service costs per cancer site, including cost, currency, setting, publication and cost year, 2016 equivalent, time frame and information source.

Cancer site	Source	Cost	Currency	Setting	Pub year	Cost year	2016 €	Time horizon of costs (see footnotes)
Oral cavity	https://pubmed.ncbi.nlm.nih.gov/29299769	46,082	CND	Canada	2018	2014	31,910	a
Oesophagus	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5344366/	43,409	CND	Canada	2017	2009	29,261	b
Nasopharynx	https://pubmed.ncbi.nlm.nih.gov/21228314/	20,981	CND	Canada	2017	2009	14,143	b
Pharynx	https://pubmed.ncbi.nlm.nih.gov/29299769/	28,777	CND	Canada	2018	2014	19,927	a
Liver	https://pubmed.ncbi.nlm.nih.gov/21228314/	23882	CND	Canada	2017	2009	16,098	b
Uterus	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5344366/	13,491	CND	Canada	2017	2009	9,094	b
Myeloma	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5344366/	27,049	CND	Canada	2017	2009	18,233	b
Thyroid	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5344366/	9,941	CND	Canada	2017	2009	6,701	b
Gallbladder	https://pubmed.ncbi.nlm.nih.gov/21228314/	20,981	CND	Canada	2017	2009	14,143	b
Larynx	https://pubmed.ncbi.nlm.nih.gov/23974964	36,476	EUR	France	2014	2010	38,722	c

Lung	https://pubmed.ncbi.nlm.nih.gov/23974964	33422	EUR	France	2014	2010	35,480	c
Sino-nasal	https://pubmed.ncbi.nlm.nih.gov/23974964	36,476	EUR	France	2014	2010	38,722	c
Colon	https://pubmed.ncbi.nlm.nih.gov/21638069	37,417	EUR	Ireland	2012	2008	41,390	d
Rectal	https://pubmed.ncbi.nlm.nih.gov/21638069	43,502	EUR	Ireland	2012	2008	48,122	d
Breast	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3107566/	12,595	STG	United Kingdom	2015	2011-2012	14,900	e
Pancreas	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5018231/	65,500	USD	United States	2012	2009	50,172	f
Stomach	https://pubmed.ncbi.nlm.nih.gov/21228314/	80,270	USD	United States	2011	2010	64,276	d
Kidney	https://pubmed.ncbi.nlm.nih.gov/21228314/	41,961	USD	United States	2011	2010	33,600	d
Leukaemia	https://pubmed.ncbi.nlm.nih.gov/21228314/	38,031	USD	United States	2011	2010	30,453	d
Ovary	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5709160/	81,628	USD	United States	2017	2013	62,253	g
Brain and CNS	https://pubmed.ncbi.nlm.nih.gov/21228314/	125,766	USD	United States	2011	2010	100,707	d

Time horizon of costs: [a]Seems to be life-course costs but attributed to first year post-diagnosis; [b]six months post-diagnosis; [c]annual average prevalent cost; [d] first year post-diagnosis [e]15 months post-diagnosis; [f]average cost per case; [g]first year post-surgery.