The Economics of Cancer Screening and Services

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    - Mortality
    - Morbidity
    - Cost

  - Contributions of economics
    - Evaluation
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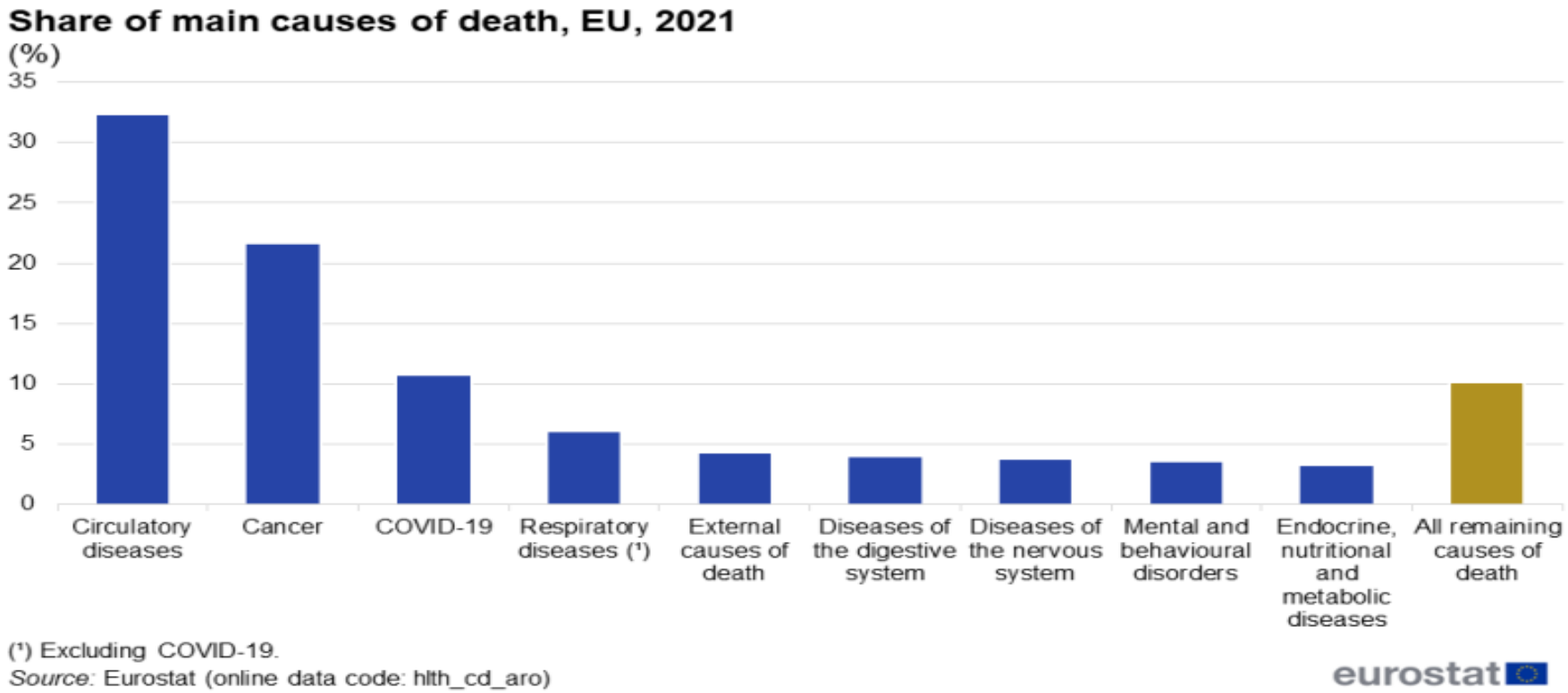
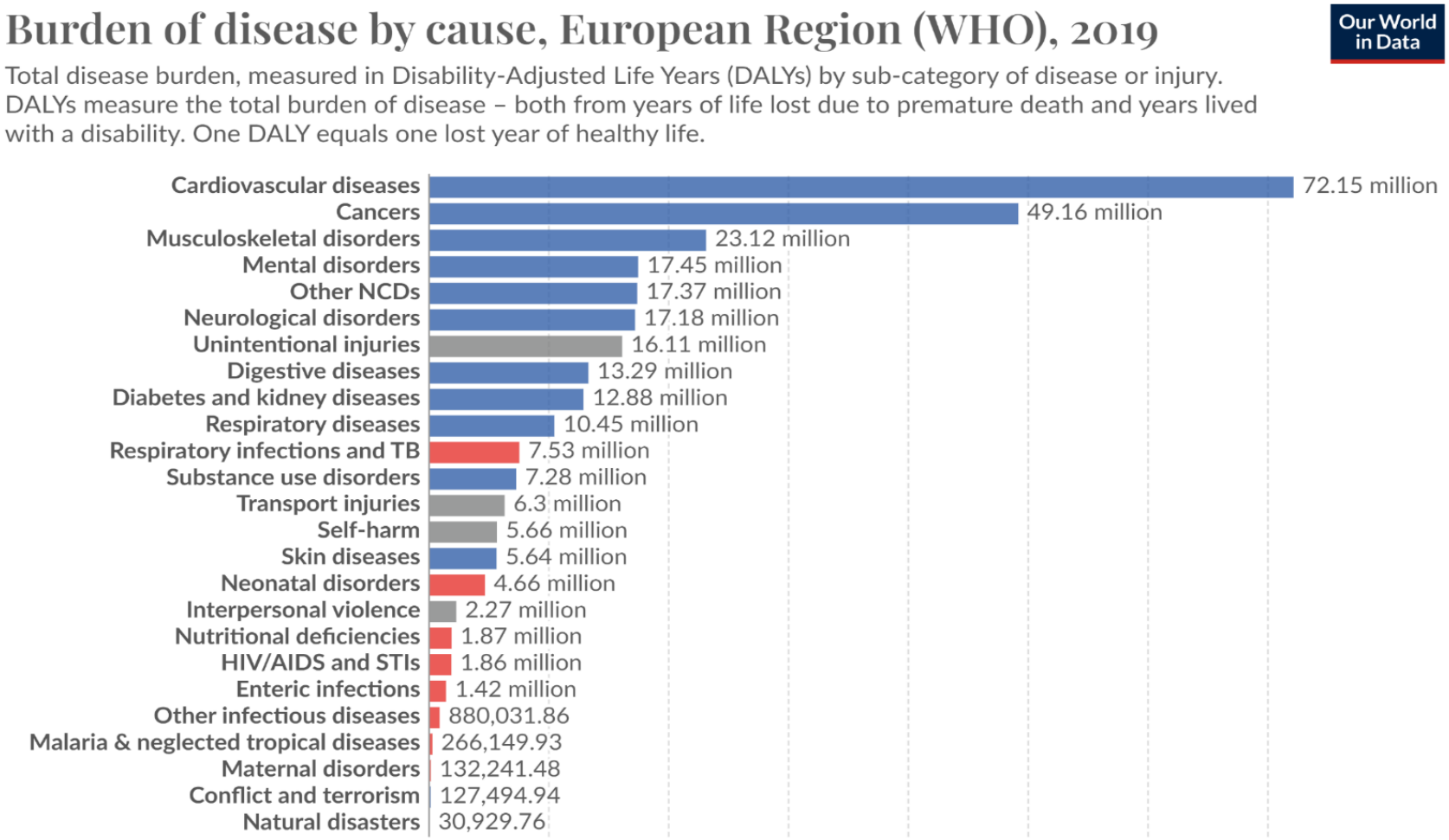
Cancer mortality and morbidity

- Now cancer is the second largest source of deaths in the EU (after cardiovascular disease



Cancer is the second largest source of DALYs in the EU (after cardiovascular diseases)



Health-related quality of life and cancer

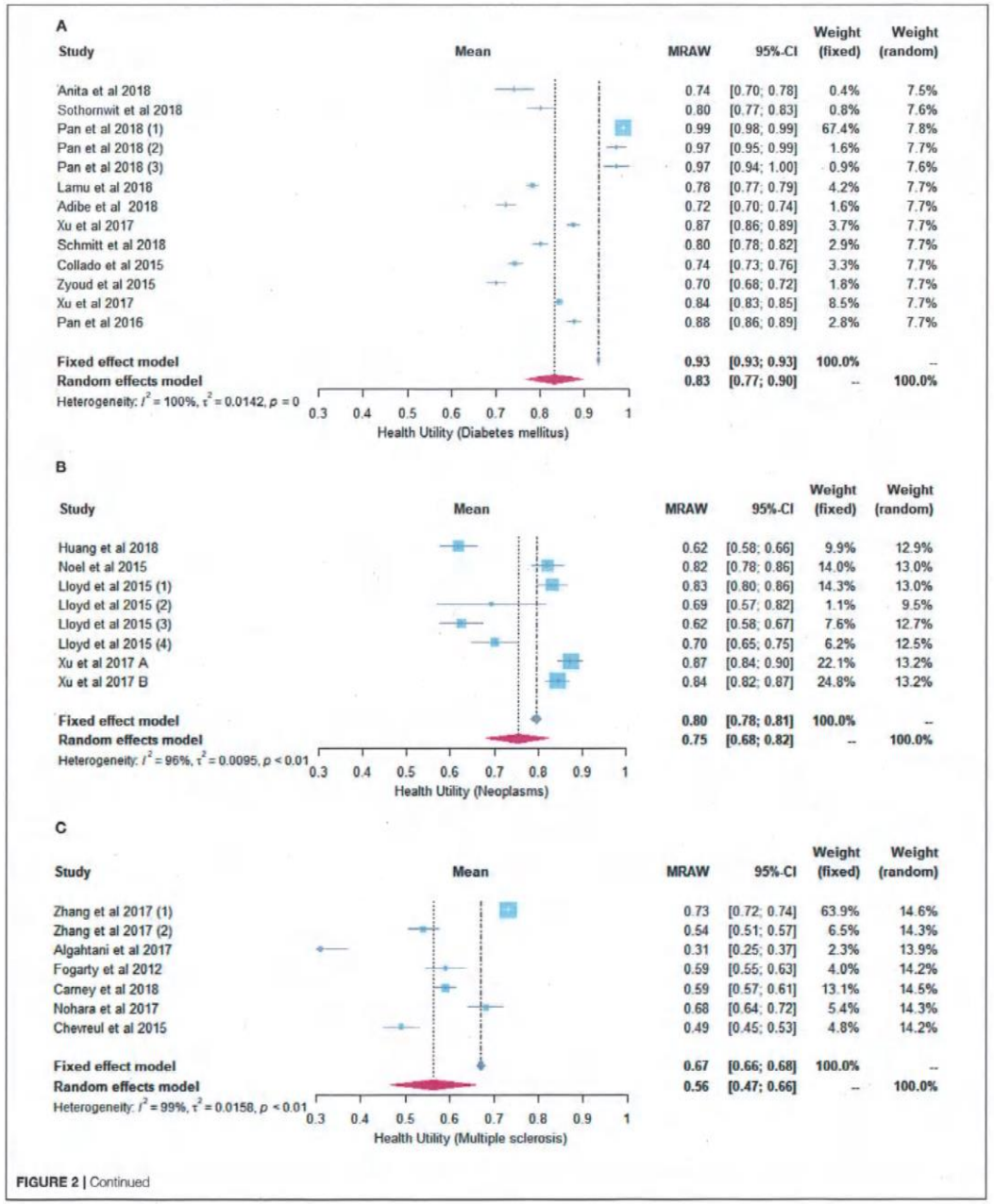


FIGURE 2 | Continued

FIGURE 2 | (A) Forest plot of the health utility of patients with diabetes mellitus. **(B)** Forest plot of the health utility of patients with neoplasms. **(C)** Forest plot of the health utility of patients with multiple sclerosis. **(D)** Forest plot of the health utility of patients with cardiovascular diseases. **(E)** Forest plot of the health utility of patients with chronic obstructive pneumonia disease. **(F)** Forest plot of the health utility of patients with human immunodeficiency virus infection. **(G)** Forest plot of the health utility of patients with chronic kidney disease.

Source: Zhou T, Guan H, Wang L, Zhang Y, Rui M, Ma A. Health-Related Quality of Life in Patients With Different Diseases Measured With the EQ-5D-5L: A Systematic Review. Front Public Health. 2021 Jun 29;9:675523. doi: 10.3389/fpubh.2021.675523

The cost of screening and cancer care

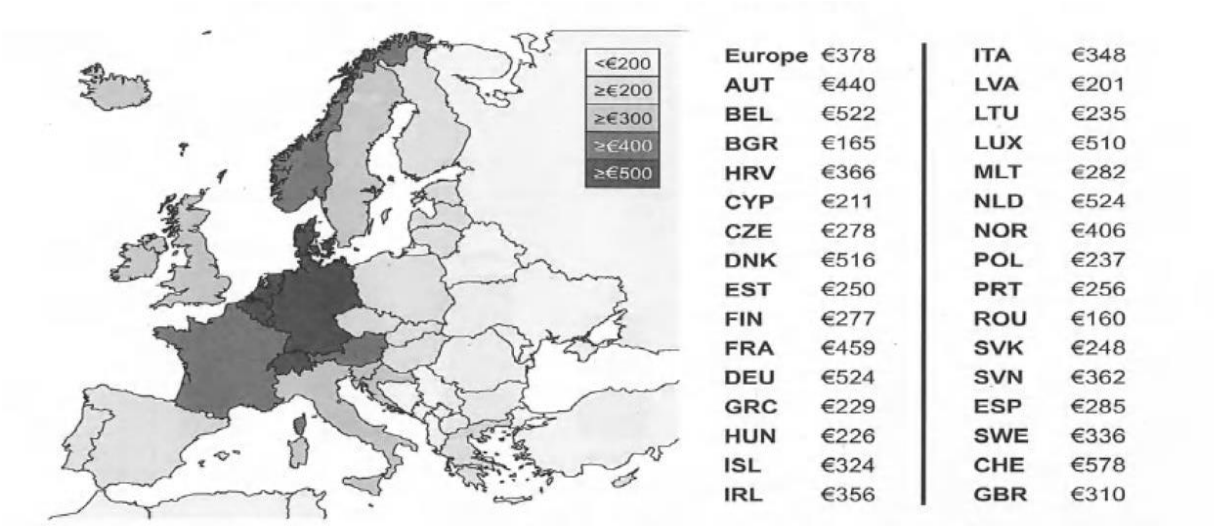
- The total cost of cancer was €199 billion in Europe (EU-27 plus Iceland, Norway, Switzerland, and the United Kingdom) in 2018 (Hofmarcher et al., 2020)
- Spending on cancer research has doubled since the mid-1990s, driven by demographic developments and advancements in treating various tumor types
- In 2020, cancer research spending reached €103 billion
- This substantial economic impact underscores the urgency of effective cancer prevention, early detection, and treatment

- There are significant healthcare and non-healthcare costs associated with cancer

Table 1
Total cost of cancer (in million V) in Europe in 2018, by country and component.

Country	Direct costs			Informal care costs	Indirect costs		Total costs
	Health expenditure on cancer care	Share of total health expenditure	Cancer drugs[a]		Productivity loss from premature mortality	Productivity loss from morbidity	
Austria	2553	6.4%[b]	952	398	1080	281	4312
Belgium	3240	6.9%[b]	1024	693	1406	1244	6583
Bulgaria	320	7.1%[b]	216	43	174	49	587
Croatia	249	6.8%[b]	149	94	200	427	969
Cyprus	90	6.3%	e	24	40	9	163
Czechia	1084	7.0%	174	192	436	341	2053
Denmark	1499	4.8%	513	764	946	726	3934
Estonia	96	5.8%	5	24	61	75	255
Finland	844	4.0%	331	337	559	154	1895
France	18,707	7.1%	5184	3288	7116	4542	33,652
Germany	25,537	6.8%	7584	5141	11,516	4370	46,564
Greece	942	6.5%	44	314	607	159	2022
Hungary	618	7.1%	388	167	497	91	1372
Iceland	69	3.8%	21	20	44	40	173
Ireland	1139	5.0%[b]	308	180	526	113	1957
Italy	10,374	6.7%	4517	5165	4924	284	20,748
Latvia	111	6.4%[b]	26	33	92	39	274
Lithuania	196	6.4%[b]	55	34	113	82	426
Luxembourg	221	6.9%[b]	7	33	90	37	380
Malta	74	6.5%[b]	e	12	26	2	114
Netherlands	5309	6.9%	1072	982	2485	1387	10,163
Norway	1575	4.2%	366	362	609	666	3212
Poland	2185	7.0%	583	582	1775	784	5327
Portugal	991	5.4%	404	371	655	192	2208
Romania	712	7.1%[b]	351	159	598	160	1629
Slovakia	428	7.1%[b]	166	72	257	173	930
Slovenia	234	6.4%	105	77	166	139	616
Spain	5245	4.9%	2841	2529	3440	950	12,164
Sweden	1907	3.7%	572	491	830	960	4189
Switzerland	4366	6.0%	801	597	1716	477	7157
United Kingdom	11,691	5.0%	3249	3213	6633	1465	23,002
Europe	102,607	6.2%	32,008	26,389	49,615	20,418	199,029

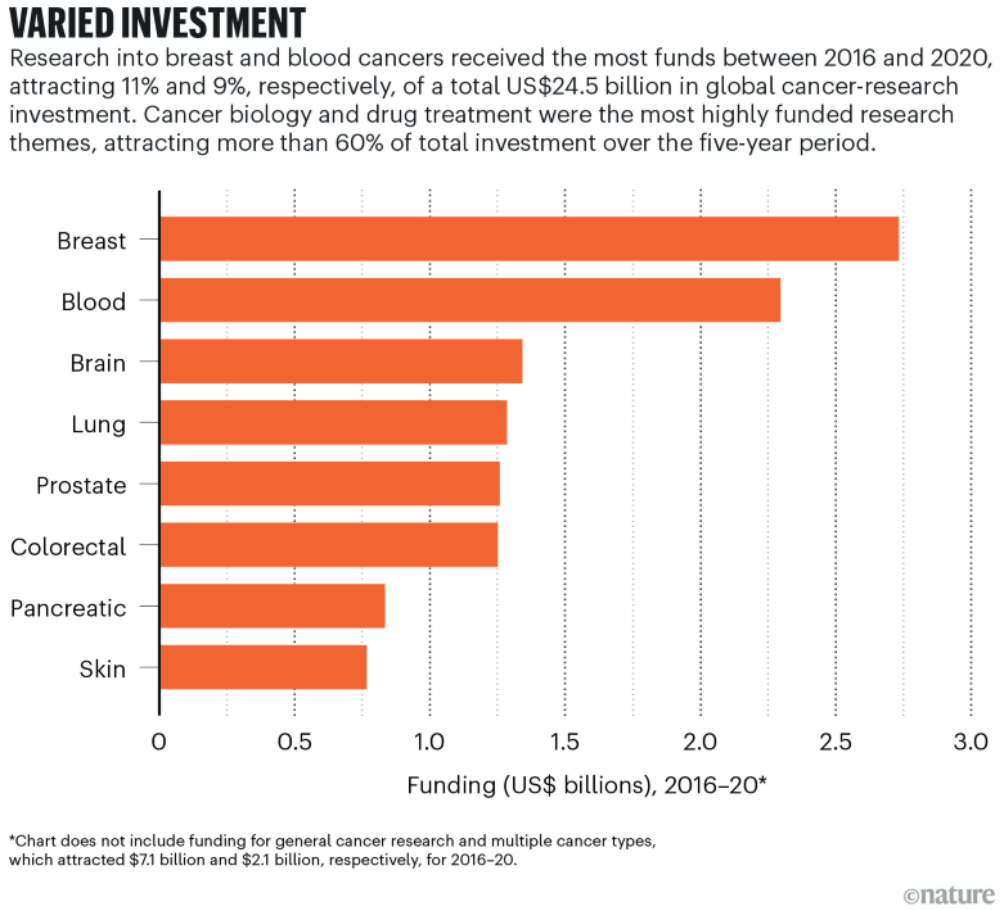
Notes: Totals of Europe and costs do not match sums of costs because of rounding. No adjustment for price differentials. Cancer drug expenditure do not include confidential rebates. Data on cancer drugs for Cyprus and Malta could not be obtained, and for Estonia, Greece, and Luxembourg they only include retail sales but not hospital sales.
[a] Cancer drug expenditure are a subset of the health expenditure on cancer care.
[b] Estimated share based on data from similar countries;



Expenditure per capita in 2018 in Europe (€ per capita PPP-adjusted)
Source: Hofmarcher et al (2020)

Research spending on cancer

- Increased significantly over time
- Varies by cancer type and country
- Some cancers receive much more research funding than others
- Challenges remain in ensuring equitable funding, effective prevention, and timely detection across all cancers



- **A growing challenge**

  - **Cancer incidence is rising:** across Europe it has risen by approximately 50% over the past two decades from 2.1 million to 3.1 million cases (1995-2018)
  - In the US the **cost of cancer care is rising** faster than any other health sector (Aksin et al, 2007)
    - Cost-increasing technology (2000-2012 increase in cost to treat each case 4.59%, cancer compared to 4.38%, all diseases in US, Petersen-Kaiser)

- Incidence
  - **Population growth and aging:** as people live longer, the risk of developing cancer naturally rises
  - **Lifestyle factors:** poor diet, lack of physical activity, smoking, alcohol consumption contribute to increased cancer risk
  - **Environmental exposures:** exposures to pollutants, radiation and occupational hazards can lead to cancer development
  - **Improved detection:** advances in diagnostic techniques and increased awareness have led to better detection and reporting rates

  - **Multimorbidity:** the median age for the development of multimorbid conditions is 56.94 years

The role of economics in screening and cancer care

- **Evaluation:** adopt new technologies that are high value and avoid technologies that are low value
- **Incentives:** payment systems, education and more carefully aligned agency
- **Prevention:** smoking, exercise, screening
- **Equity:** sources of disparities

- Evaluation
  - Cost-effectiveness analysis ***can*** be used to signal price and restrict access (Cherla et al, 2020)
    - Institute for Clinical and Economic Review (US) versus NICE in UK –
      - NICE gate-keeps in UK and can negotiate on price
      - Medicare and Medicaid are required to include nearly every FDA approved cancer drug with public formulary – ability to negotiate price reduction much less

Table 1
Cost-effectiveness evaluations and coverage recommendations from ICER and NICE.

Indication	Drug	Incremental cost-effectiveness ratio		Recommendation		Concordance of Recommendations	Reason for Discordance
		ICER	NICE	ICER	NICE		
Non-small Cell Lung Cancer	Atezolizumab (Tecentriq)	$219,179	< $71,429	High certainty for benefit despite uncertain evidence, exceeds cost-effectiveness (factor of uncertainty)	Recommended with financial agreement	Yes	N/A; not cost-effective in either US or England
	Nivolumab (Opdivo)	$415,950	$72,379	High certainty for benefit despite uncertain evidence, exceeds cost-effectiveness (factor of uncertainty)	Recommended with a financial and post-market efficacy agreement	Yes	N/A; not cost-effective in either US or England
	Pembrolizumab (Keytruda)	$236,492	< $71,429	High certainty for benefit despite uncertain evidence, exceeds cost-effectiveness (factor of uncertainty)	Recommended with financial agreement	Yes	N/A; not cost-effective in either US or England
Ovarian, Fallopian, & Peritoneal Cancer	Rucaparib (Rubraca)	$369,175	> $42,857	Quality adjusted and OS benefit but not priced in alignment with benefit	Recommended with a financial and post-market efficacy agreement	Yes	N/A; not cost-effective in either US or England
	Niraparib | Zejula)	$291,454	$53,804	Quality adjusted and OS benefit, but the price is not aligned with the benefit	Recommended with a financial and post-market efficacy agreement	Yes	N/A; not cost-effective in either US or England
	Olaparib (Lynparza)	$324,100	> $42,857	Quality adjusted and OS benefit but not priced in alignment with benefit for platinum sensitive disease	Recommended with a financial and post-market efficacy agreement	Yes	N/A; not cost-effective in either US or England
Multiple Myeloma	Panobinostat (Farydak)	$10,230	< $35,765	Promising but concerns over toxicity, long-term cost-effectiveness is uncertain	Recommended with financial agreement	Yes	N/A; cost-effective in both US and England
	Ixazomib (Ninlaro)	$433,794	< $42,857	Moderate certainty for health benefit, not representative of long-term value at list price	Recommended with a financial and post-market efficacy agreement	No	Higher price in the US
Acute Lymphoblastic Leukemia	Tisagenlecleucel (Kymriah)	$45,871	> $42,857 – $64,286	Net health benefit, potentially cost-effective but more evidence for PFS and OS is needed to reduce uncertainty of clinical and cost-effectiveness	Recommended with a financial and post-market efficacy agreement	No	Higher cost-effectiveness threshold in the US
Lymphoma	Axicabtagene ciloleucel (Yescarta)	$136,078	> $71,429	Net health benefit, cost-effective	Recommended with a financial and post-market efficacy agreement	No	Higher cost-effectiveness threshold in the US
Prostate Cancer	Enzalutamide (Xtandi)	$84,000	$80,240	High certainty of substantial net health benefit (based on MFS and immature OS data), cost-effective	Not recommended; immature OS evidence not significant, not cost-effective with financial agreement	No	Higher cost-effectiveness threshold in the US, discordance regarding clinical effectiveness

Abbreviations: ICER; Institute for Clinical and Economic Review, NICE; the National Institute for Health and Care Excellence, PFS; progression-free survival, MFS; metastasis-free survival, OS; overall survival.
Notes: Drug evaluations from ICER and NICE differ because of their function within the two healthcare systems. In the United Kingdom, NICE makes recommendations for funding decisions in the NHS whereas in the United States, ICER does not have a funding mandate and does not make formal decisions for reimbursement. Therefore, the recommendations from the two agencies are distinct and presented differently.
1. For NICE's assessment of atezolizumab the ICER was confidential due to the patient access scheme. NICE explained the ICER was similar to pembrolizumab and likely cost-effective. Less than $71,429 per QALY was used as an educated assumption based on the information given.
2. For the assessment of rucaparib, ICER used comparators of Pegylated liposomal doxorubicin + carboplatin while NICE used comparators of routine surveillance or olaparib.
3. For NICE's assessment of olaparib the base-case ICER was $42,857 per QALY but this was stated to over value treatment. NICE stated treatment was not a cost-effective use of resources compared with routine surveillance therefore an educated assumption (greater than £30 K per QALY) was used.
4. ICER compared a combination therapy of panobinostat with bortezomib and dexamethasone versus bortezomib and dexamethasone. NICE compared panobinostat with bortezomib and dexamethasone versus lenalidomide and dexamethasone. ICER also made this comparison but found that lenalidomide and dexamethasone was cheaper and more cost-effective than the therapy with panobinostat.
5. Ixazomib is indicated with lenalidomide and dexamethasone.
6. For tisagenlecleucel, NICE and ICER used different comparators. ICER compared tisagenlecleucel to clofarabine while NICE compared it with a composite of salvage chemotherapy as well as blinatumomab. NICE determined that tisagenlecleucel had an incremental cost effectiveness ratio > $42,857 when compared with salvage chemotherapy and > $64,286when compared with blinatumomab.

A. Cherla et al. / EClinicalMedicine 29–30 (2020) 100625

The NHS ends up paying less for new cancer drugs

Interestingly - the cost per QALY for breast, cervical and colorectal cancer screening has been reported at

$11.8K-$29.6K colorectal
$21.8-$27.6 cervical
$55.2 - $78.3 breast

Allowing for competing risks (Ratushnyak et al, 2019)

The role of economics in screening and cancer care

- **Evaluation:** adopt new technologies that are high value and avoid technologies that are low value
- **Incentives:** payment systems, education and more carefully aligned agency
- **Prevention:** smoking, exercise, screening
- **Equity:** sources of disparities

- Market based reforms

  - **Demand side measures**
    - Reference based pricing
    - Deductibles, co-pays, coinsurance

    } choke demand

  - **Supply side measures**
    - Through information and integration – wide variations in prices for procedures and in practice (Laviana et al, 2020)

  - **Alternatives to low value active treatment**
    - Palliative care – significantly lower costs in last year of life for hospice versus non-hospice patients $62,819 versus $71,517 (Obermeyer et al, 2014) supported by more recent studies (Hoverman et al, 2020)

  - **Policy environment**
    - Government guidelines and incentives
    - Reimbursement policies
    - Legal frameworks

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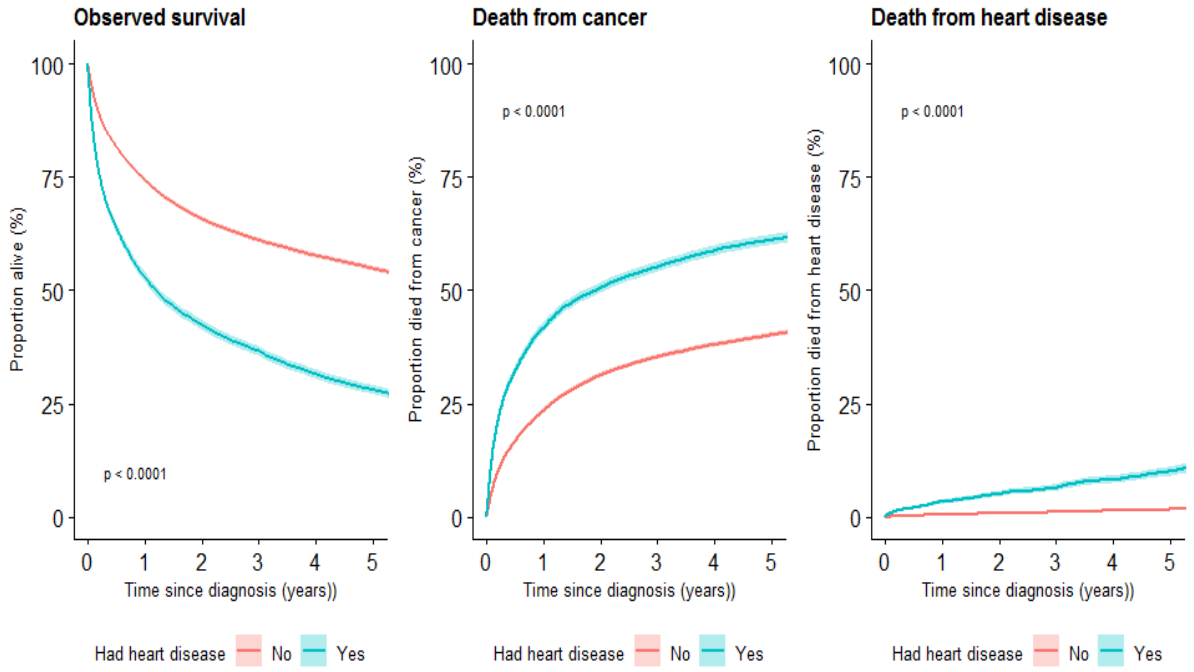
Understanding cancer means understanding its relationships with other conditions

Cancer survival by presence of heart condition prior to diagnosis: All cancers (ex NMSC) diagnosed 2011-2014



O'Neill et al. BMC Cancer (2022) 22:847
https://doi.org/10.1186/s12885-022-09944-z

BMC Cancer

RESEARCH Open Access

Survival of cancer patients with pre-existing heart disease

Ciaran O'Neill[1,2*], David W. Donnelly[1], Mark Harbinson[3], Therese Kearney[2], Colin R. Fox[1], Gerard Walls[4,5] and Anna Gavin[1]

Abstract

Background: While cancer outcomes have improved over time, in Northern Ireland they continue to lag behind those of many other developed economies. The role of comorbid conditions has been suggested as a potential contributory factor in this but issues of data comparability across jurisdictions has inhibited efforts to explore relationships. We use data from a single jurisdiction of the UK using data from - the Northern Ireland Cancer Registry (NICR), to examine the association between mortality (all-cause and cancer specific) and pre-existing cardiovascular diseases among patients with cancer.

Materials and Methods: All patients diagnosed with cancer (excluding non-melanoma skin cancer) between 2011 and 2014 were identified from Registry records. Those with a pre-existing diagnosis of cardiovascular diseases were identified by record linkage with patient hospital discharge data using ICD10 codes. Survival following diagnosis was examined using descriptive statistics and Cox proportional hazards regression analyses. Analyses examined all-cause mortality and cancer specific mortality for lung, colorectal, breast and prostate cancer. As well as cardiovascular diseases, regression models controlled for age, gender (where appropriate), deprivation (as quintiles), stage at diagnosis and other comorbidities.

Results: Almost 35,000 incident cancer cases were diagnosed during the study period of which approximately 23% had a prior heart condition. The pan-cancer hazard ratio for death in the presence of pre-existing cardiovascular diseases was 1.28 (95% CI: 1.18-1.40). All-cause and cancer specific mortality was higher for patients with cardiovascular diseases across lung, female breast, prostate and colorectal cancer groups after controlling for age, gender (where appropriate), deprivation (as quintiles), stage at diagnosis and other comorbidities.

Conclusion: Pre-existing morbidity may restrict the treatment of cancer for many patients. In this cohort, cancer patients with pre-existing cardiovascular diseases had poorer outcomes than those without cardiovascular diseases. A high prevalence of cardiovascular diseases may contribute to poorer cancer outcomes at a national level.

Keywords: survival, cancer, pre-existing cardiovascular disease

Similar patterns for lung, colorectal, female breast cancer and prostate cancer

Pre-existing CVD effects treatment and cost
Emergent CVD (toxicity) effects costs and outcomes

The role of economics in screening and cancer care

- **Evaluation:** adopt new technologies that are high value and avoid technologies that are low value
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Inequalities in cancer (screening)

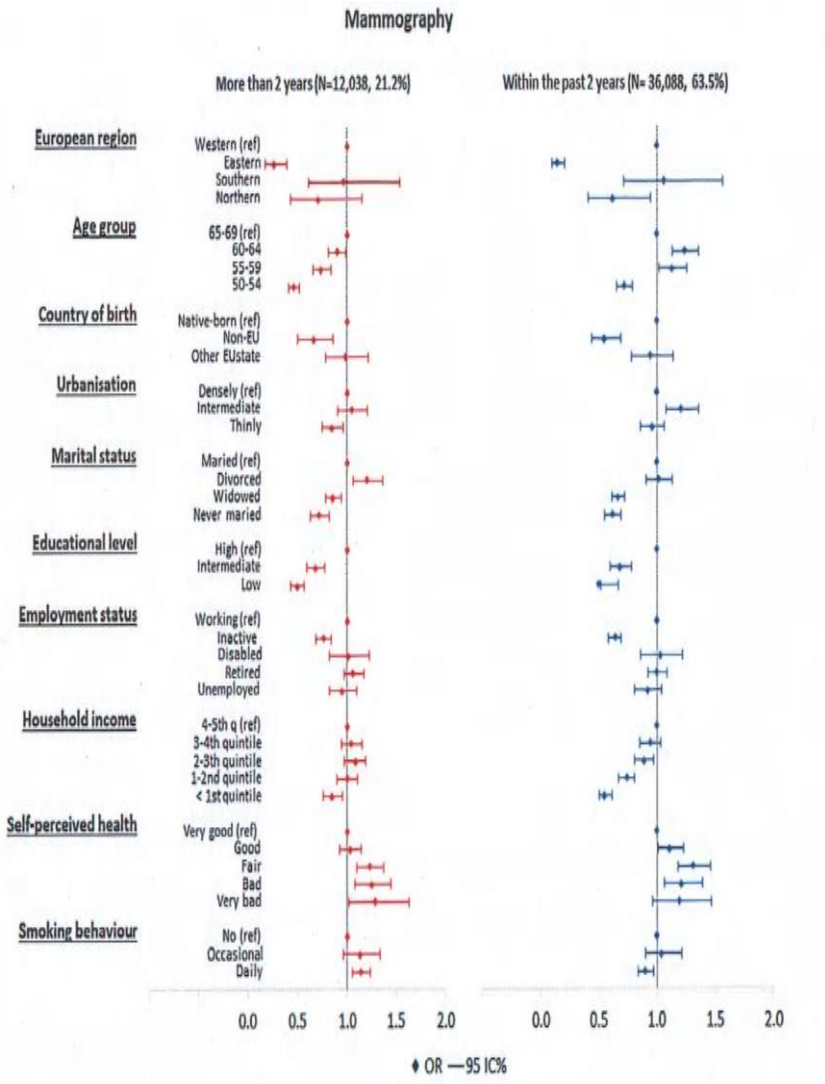


Fig. 1. Adjusted odds ratios and 95% confidence intervals of having mammography more than two years ago and within the past two years (multivariate analysis). The base category is "never screened".

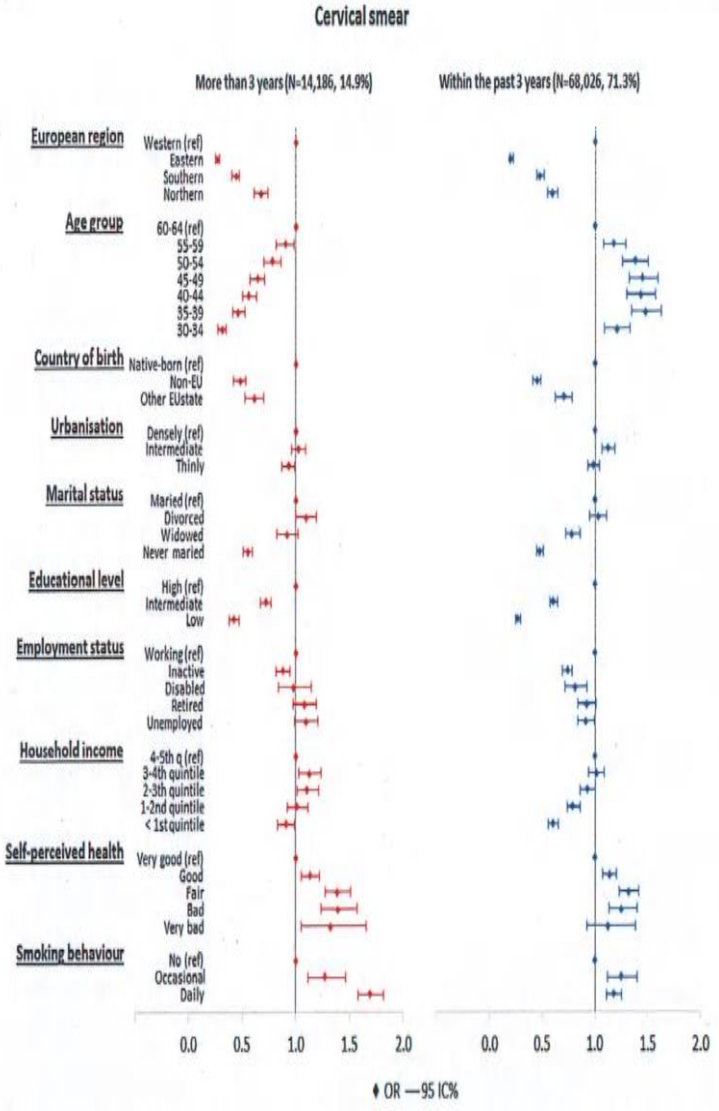


Fig. 2. Adjusted odds ratios and 95% confidence intervals of having a cervical smear test more than three years ago and within the past three years (multivariate analysis). The base category is "never screened".

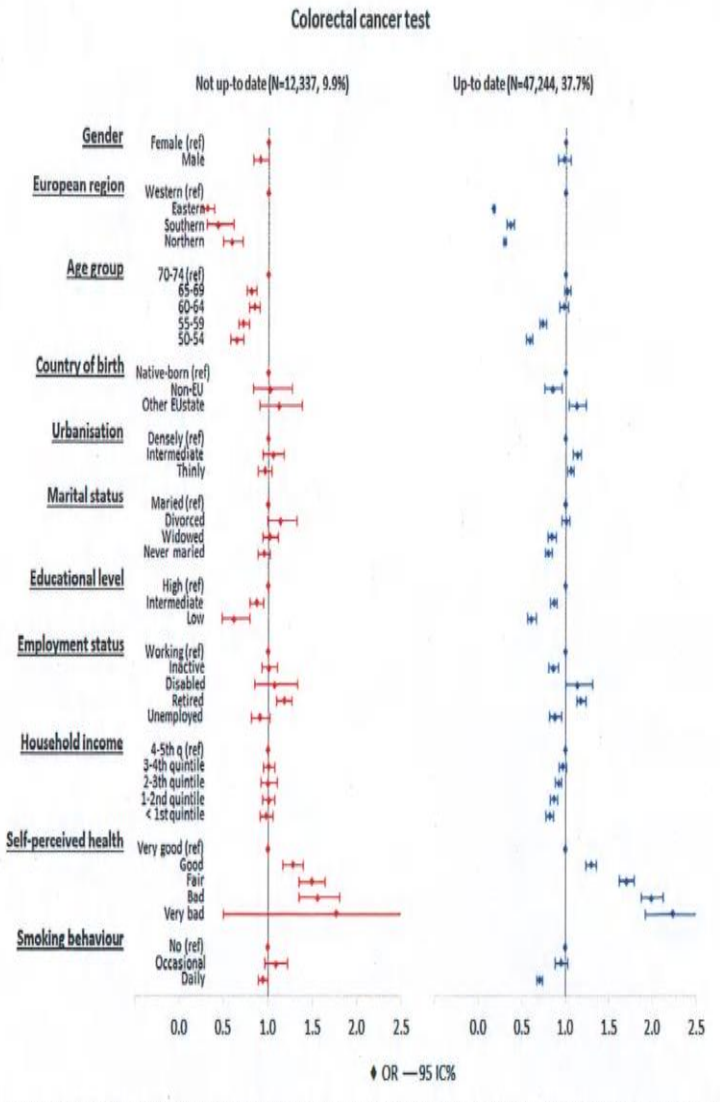
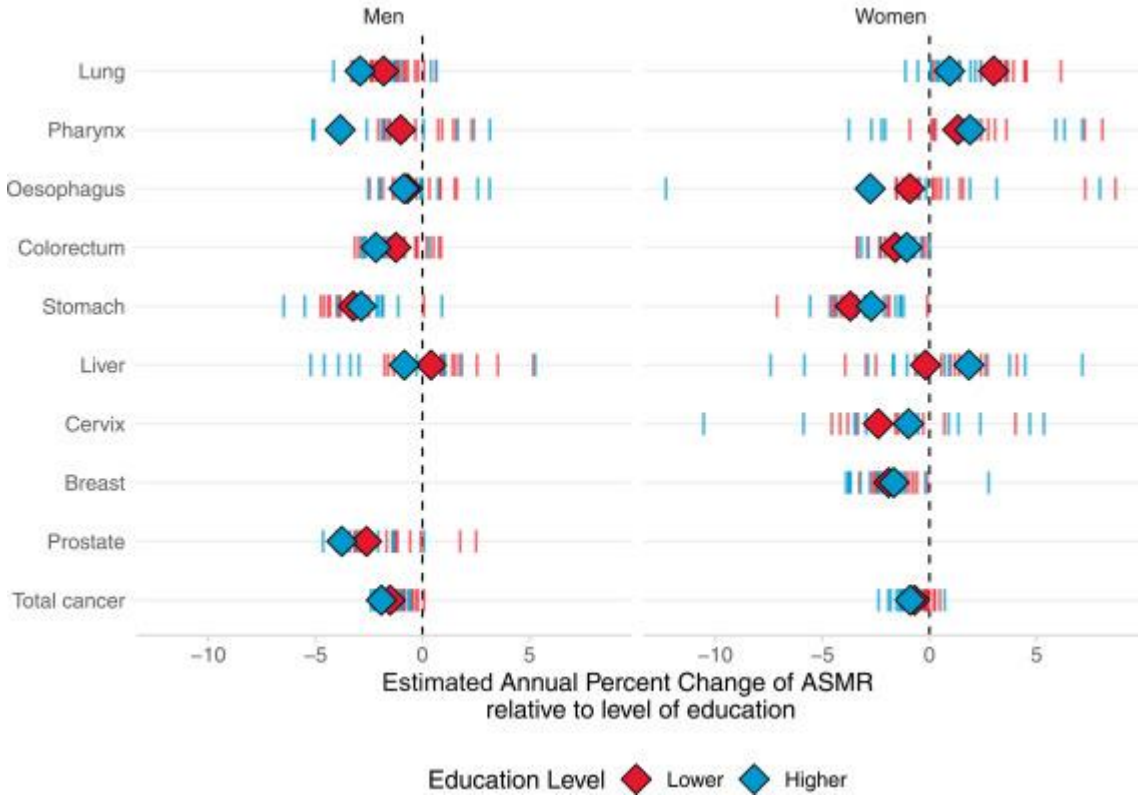


Fig. 3. Adjusted odds ratios and 95% confidence intervals of being up-to date with colorectal cancer testing (having a FOB-test within the past 2 years or colonoscopy within the past 10 years) or being not up-to date (having a FOB-test more than 2 years ago or colonoscopy more than 10 years ago) (multivariate analysis). The base category is "never screened".

Source: Bozar et al 2022, Socio-economic inequality of utilization of cancer testing in Europe: A cross-sectional studyPrev Med Rep. 2022 Feb 8;26:101733. doi: 10.1016/j.pmedr.2022.101733. PMID: 35198362;

Inequalities in cancer (outcomes)



Source: Varcarella et al, 2022. Socioeconomic inequalities in cancer mortality between and within countries in Europe: a population-based study Lancet Reg Health Eur. 2022 Nov 28;25:100551. doi: 10.1016/j.lanepe.2022.100551.

SES has a role in screening uptake

As does ethnicity

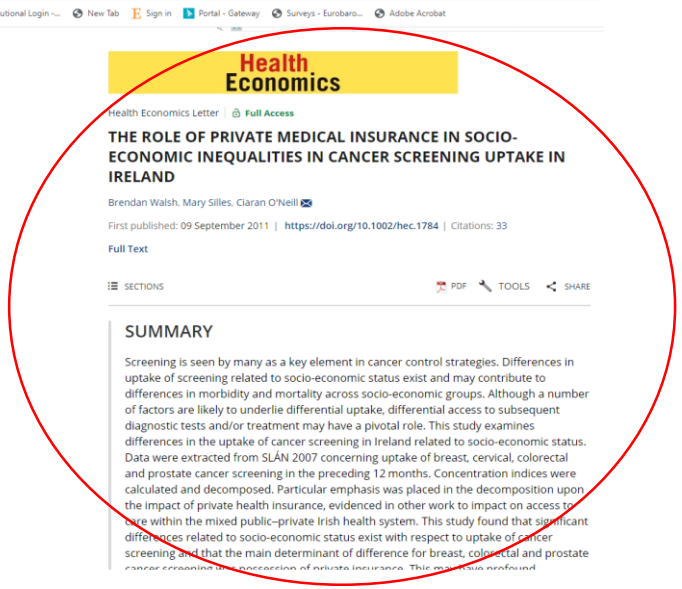
Insurance

Health preferences

Private care has a role in interval between diagnosis and treatment

The importance of socio-economic variables in cancer screening participation: A comparison between population-based and opportunistic screening in the EU-15

Brendan Walsh, Mary Silles, Ciarán O'Neill



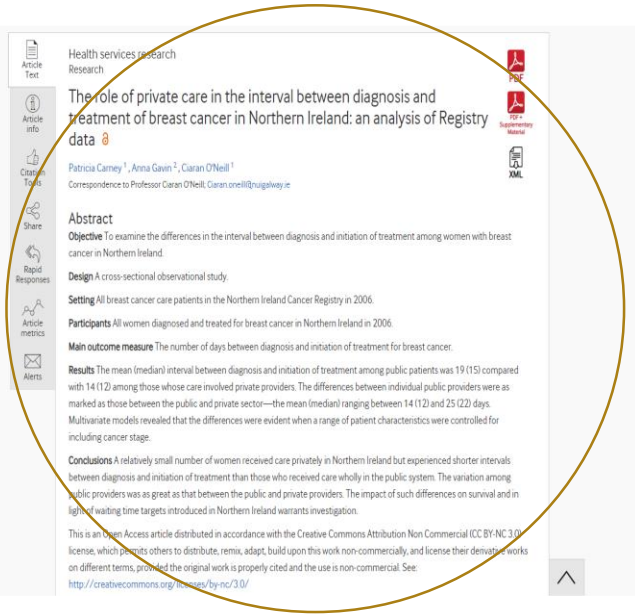
Health Economics

THE ROLE OF PRIVATE MEDICAL INSURANCE IN SOCIO-ECONOMIC INEQUALITIES IN CANCER SCREENING UPTAKE IN IRELAND

Brendan Walsh, Mary Silles, Ciaran O'Neill

SUMMARY

Screening is seen by many as a key element in cancer control strategies. Differences in uptake of screening related to socio-economic status exist and may contribute to differences in morbidity and mortality across socio-economic groups. Although a number of factors are likely to underlie differential uptake, differential access to subsequent diagnostic tests and/or treatment may have a pivotal role. This study examines differences in the uptake of cancer screening in Ireland related to socio-economic status. Data were extracted from SLÁN 2007 concerning uptake of breast, cervical, colorectal and prostate cancer screening in the preceding 12 months. Concentration indices were calculated and decomposed. Particular emphasis was placed in the decomposition upon the impact of private health insurance, evidenced in other work to impact on access to care within the mixed public–private Irish health system. This study found that significant differences related to socio-economic status exist with respect to uptake of cancer screening and that the main determinant of difference for breast, colorectal and prostate



Health services research

The role of private care in the interval between diagnosis and treatment of breast cancer in Northern Ireland: an analysis of Registry data

Abstract

Objective To examine the differences in the interval between diagnosis and initiation of treatment among women with breast cancer in Northern Ireland.

Design A cross-sectional observational study.

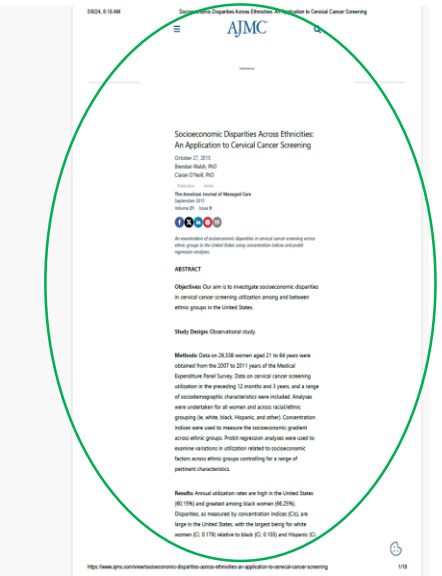
Setting All breast cancer care patients in the Northern Ireland Cancer Registry in 2006.

Participants All women diagnosed and treated for breast cancer in Northern Ireland in 2006.

Main outcome measure The number of days between diagnosis and initiation of treatment for breast cancer.

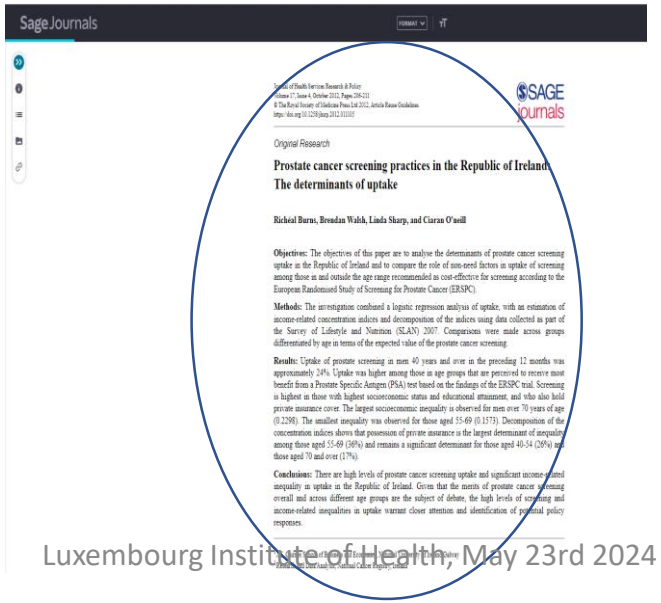
Results The mean (median) interval between diagnosis and initiation of treatment among public patients was 19 (15) compared with 14 (12) among those whose care involved private providers. The differences between individual public providers were as marked as those between the public and private sector—the mean (median) ranging between 14 (12) and 25 (22) days. Multivariate models revealed that the differences were evident when a range of patient characteristics were controlled for including cancer stage.

Conclusions A relatively small number of women received care privately in Northern Ireland but experienced shorter intervals between diagnosis and initiation of treatment than those who received care wholly in the public system. The variation among public providers was as great as that between the public and private providers. The impact of such differences on survival and in light of waiting time targets introduced in Northern Ireland warrants investigation.



AJMC

Socioeconomic Disparities Across Ethnicities: An Application to Cervical Cancer Screening



SAGE Journals

Original Research

Prostate cancer screening practices in the Republic of Ireland: The determinants of uptake

Richéal Burns, Brendan Walsh, Linda Sharp, and Ciaran O'neill

Preventive Medicine Reports

Health preferences and preventive care utilisation: How EQ-5D-5L health preferences may affect uptake

Dan Kelleher, Edel Doherty, Ciaran O'Neill

Inequalities in experience of financial toxicity (objective financial burden and subjective financial distress that can attend a cancer diagnosis and treatment) Zafar et al, 2013

-
  - More evident in US than UK
  - More evident among those with lower income
  - More evident among those of working age

- Final thoughts
  - Cancer presents many challenges
  - Economics can help inform our responses
  - There is reason to be concerned
  - There is also reason to be hopeful
    - Survival is improving
    - Rising costs are not immutable
    - Widening inequalities are not immutable

Joyce et al, 2019

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Thank you!

Any questions