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Original Research

Mapping the European cancer research landscape: An evidence base for national and Pan-European research and funding

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Abstract ***Background:*** Cancer research is among the most active biomedical research domains for the European Union (EU). However, little quantitative empirical evidence is available to guide the decisions on the choice of disease site to study, specific research domain focus or allocation of research resources. To inform national/supranational cancer research policy, high-resolution intelligence is needed.
Methods: We performed a bibliometric analysis of European cancer research papers in the Web of Science from 2002 to 2013 to quantify research activity in each of the 28 EU Member States, along with Iceland, Norway and Switzerland (EUR31), which cancer sites/research domains they addressed, and their sources of financial support (2009–2013).
Findings: Cancer research papers from EUR31 correlated well with national Gross Domestic Products ($r^2 = 0.94$). However, certain cancer sites (lung, oesophagus and pancreas) were under-researched relative to their disease burden, whereas central nervous system and blood cancers were more generously supported than their burden would warrant. An analysis of research domains indicated a paucity of research on radiotherapy (5%), palliative care (1.2%) and quality of life (0.5%). European cancer research funding in 2012–2013 amounted to ~€7.6 billion and came from diverse sources, especially in western Europe/Scandinavia, where in nine countries the charitable sector outspent the government but not in Eastern Europe where charitable research funding barely exists.
Interpretation: Several countries need to increase their cancer research outputs substantially, and/or alter their research portfolios to better match their growing (and changing) cancer burden. More co-ordination among funding agencies is required, so that resources can be

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attuned to align activities to research gaps and perceived clinical needs. In Eastern Europe, the charitable funding sector needs to be developed, so that both public and patient advocacy can have an active role in research.
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Research in Context

Evidence before this study

Previous papers on cancer research outputs have only given details on the total numbers of papers published, without division by cancer site or research domain. Moreover, most of these studies only examined papers in specialist cancer journals, which account for fewer than half of total papers. A study on funding did estimate total global research expenditure, but without a detailed analysis of funding sources.

Added value of this study

This study examined effectively all cancer research papers published in Europe for a 12-year period and their division by cancer site and research domain. Comparisons were made with national wealth and with disease burden. Funding data, both explicit and implicit, were obtained for a 5-year period and analysed by country and by sector, and the leading funders were identified.

Implications of all the available evidence

Research publications on cancer in Europe are somewhat low compared with its large and growing disease burden, especially in some countries relative to their Gross Domestic Product. From 2002 to 2013, cancer's fraction of biomedical research increased from 11.6% to 11.9%, but the burden of cancer across Europe was much higher, accounting for 16% of all disability-adjusted life years in 2002 and 20% in 2012. The data indicate that cancer sites such as central nervous system and blood cancers appear to be over-researched, whereas lung, pancreatic and oesophageal cancers are under-researched. Certain research domains, such as radiotherapy, palliative care and quality of life, are also under-researched, particularly in Southern and Eastern Europe. Funding is very diffuse, which makes potential co-ordination and any change in research direction or prioritisation difficult, especially in Scandinavia which has many private non-profit sources. New funding modalities are also needed to help certain European countries to improve their performance in neglected research areas.

1. Introduction

Cancer research is one of the largest components of biomedical research in European countries, but a quantitative analysis has been lacking. Many studies only covered specialist cancer literature [1,2], whereas we have previously found that more than half of all cancer papers were published in general medical journals [3]. Some papers have looked at individual cancer sites, for example, lung cancer [4] and colorectal cancer [5] or research domains, for example, palliative care [6] and surgery [7], and are limited in scope. There is less information on the funding of cancer research in Europe, and existing data are now out of date [8].

Cancer research paper outputs can be compared with the burden of the disease, as measured by disability-adjusted life years (DALYs), where one DALY corresponds to 1 year of 'healthy' life lost [9]. Globally, cancer accounts for a growing burden (5.1% of DALYs in 2002; 8.1% in 2012) but it is over-researched relative to this burden (11.9% of biomedical research in 2002 and 13.2% in 2012). However, in Europe, although the burden of cancer has increased (16.0% of total causes of DALYs in 2002, rising to 19.5% in 2012), the level of cancer-specific biomedical research has remained almost static (12.1% of biomedical research in 2012 compared to 11.6% in 2002) (all $p < 0.001\%$), thus rendering cancer an under-researched disease in Europe. This is also true in other high-income countries [10].

Data on disease burden were obtained from the World Health Organization (WHO) websites for each of the 28 European Union Member States (EU MS) and for Iceland, Norway and Switzerland (EUR31), for the years 2002 and 2012 [9]. Increases in disease burden have occurred across the EUR31, with the Netherlands having the highest (2002: 18% and 2012: 23%), Cyprus (8%) the lowest in 2002, and Bulgaria (15%) the lowest in 2012.

We examined cancer research papers published by the EUR31 from 2002 to 2013, and their funding from 2009 to 2013. Papers were accessed both from specialist and from general medical journals and analysed by cancer anatomical site and research domain. Country Gross Domestic Product (GDP) data were used to contextualise the findings.

2. Methodology

2.1. Outputs of research papers and classification by subject area

Articles and reviews in the Web of Science (WoS©; Clarivate Analytics) for the years 2002–2013 and for the

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