

# The State of Lung Cancer Research: A Global Analysis



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## ABSTRACT

**Introduction:** Lung cancer is the leading cause of years of life lost because of cancer and is associated with the highest economic burden relative to other tumor types. Research remains at the cornerstone of achieving improved outcomes of lung cancer. We present the results of a comprehensive analysis of global lung cancer research between 2004 and 2013 (10 years).

**Methods:** The study used bibliometrics to undertake a quantitative analysis of research output in the 24 leading countries in cancer research internationally on the basis of articles and reviews in the Web of Science (WoS) database.

**Results:** A total of 32,161 lung cancer research articles from 2085 different journals were analyzed. Lung cancer research represented only 5.6% of overall cancer research in 2013, a 1.2% increase since 2004. The commitment to lung cancer research has fallen in most countries apart from China and shows no correlation with lung cancer burden. A review of key research types demonstrated that diagnostics, screening, and quality of life research represent 4.3%, 1.8%, and 0.3% of total lung cancer research, respectively. The leading research types were genetics (20%), systemic therapies (17%), and prognostic biomarkers (16%). Research output is increasingly basic science, with a decrease in clinical translational research output during this period.

**Conclusions:** Our findings have established that relative to the huge health, social, and economic burden associated with lung cancer, the level of world research output lags

significantly behind that of research on other malignancies. Commitment to diagnostics, screening, and quality of life research is much lower than to basic science and medical research. The study findings are expected to provide the requisite knowledge to guide future cancer research programs in lung cancer.

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Drs. Aggarwal and Lewison contributed equally to this article.

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## Introduction

In 2013 it was estimated that there were 14.9 million incident cancer cases and 8.2 million deaths.<sup>1</sup> Of these cases, lung cancer remains the leading cause of cancer death globally in both high-income and low- and middle-income countries, accounting for 1.6 million cancer deaths annually (approximately 20% of total cancer deaths), with an estimated 1.8 million new cases annually worldwide.<sup>2</sup> Importantly, with the cigarette smoking habit established in lower-resource countries some years ago, the global burden of lung cancer will continue to grow for the coming decades.

It is not just the human cost that one needs to consider but the wider economic burden. A recent analysis of the costs associated with cancer care in the European Union demonstrated that relative to other cancers, lung cancer is associated with the highest economic costs (€18.8 billion or 15% of total cancer care costs) followed by breast cancer (12%) and colorectal cancer (10%).<sup>3</sup> These costs incorporate both the direct costs of managing the disease at all stages as well as the opportunity costs associated with the loss of productivity due to premature mortality and the indirect costs of informal care.

Although public health and policy efforts aim to reduce smoking initiation and increase cessation (especially in emerging economies),<sup>4,5</sup> for those in whom lung cancer has been diagnosed the outcomes remain poor. The mean age-standardized 5-year survival rate is 13.0% in Europe (varying from 9% to 14.8% across Europe)<sup>6</sup> and 16% in the United States.<sup>7</sup> The reasons are multiple and include the absence of a cost-effective screening tool, late stage at the time of diagnosis (65% of patients present with locally advanced or metastatic disease<sup>8</sup>), socioeconomic inequalities in health care access,<sup>9,10</sup> and the challenge in obtaining a histological diagnosis.<sup>11</sup> Furthermore, median survival time in advanced disease with standard chemotherapeutic regimens has not changed in the past two decades and remains at approximately 12 months.<sup>12</sup>

Cancer research is one of the most globally active domains of science, with more than \$14 billion per annum in public and private expenditure.<sup>13</sup> Research is at the core of achieving improved outcomes from cancer, be it in defining country-specific epidemiology of the disease, understanding the pathogenesis of disease, identifying new targets for therapeutic agents, or directing policy to achieve affordable and equitable outcomes.<sup>14</sup> It is therefore important to understand from a public policy perspective how, why, and which

particular research domains evolve and have an impact on outcomes.

In this article we present the results of a bibliometric analysis of global research on lung cancer between 2004 and 2013 (10 years) in the 24 leading countries in cancer research. This type of analysis is now used routinely to evaluate large numbers of scientific articles in a given research domain.<sup>15,16</sup> We examine the growth in output from these countries, their relative commitment to lung cancer research compared with all cancer research output, the main research types (e.g., genetics, chemotherapy), the amount of international collaboration as a function of the outputs of leading countries, and the impact of lung cancer research.

## Methods

We performed a bibliometric analysis of research outputs during 2004 to 2013 on the basis of articles and reviews in the Web of Science (WoS) database. This analysis contains full bibliographic information about the articles, including all addresses and the numbers of citations received by each article. The WoS is considered the optimum database for undertaking this type of evaluation as the use of additional biomedical databases does not significantly increase the yield of relevant journals.

We identified the lung cancer articles by means of a specially developed algorithm formed by the intersection of two filters. Each filter consisted of lists of specialist journals for cancer (185 journals) and lung disease (11 journals), as well as specific title words relating to both subjects. All articles within the specialist cancer or lung disease journals were selected in addition to articles in nonspecialist journals that contained one or more of the title words. This approach had a precision or specificity of 0.95 and a recall or sensitivity of the same value, which is considered very high.<sup>17</sup>

This meant that articles in general medical journals were also covered, and the 32,162 articles were in as many as 2085 different journals. Nearly all of the articles were in English (31,000 or 96.4%), but others were in 18 different languages, led by French (554), Spanish (203), and German (168). A few were in Chinese, Japanese, or Korean. This double filter would be expected to have provided excellent coverage of lung cancer research, although some basic research articles might have been omitted if there was nothing in their titles to indicate that they were directly relevant to lung cancer.

The details of the selected articles from the 24 leading research-active countries internationally were downloaded. These countries accounted for approximately 97% of all lung cancer research articles published between 2004 and 2013. The countries included were as follows: Australia, Austria, Belgium, Brazil,

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