

## Research brief

# A bibliometric analysis by geographic area of published research in several biomedical fields, 1995–2003

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## ABSTRACT

We summarized the findings of several studies of ours to compare the quantity and quality of published research from around the world for the years 1995 to 2003. We evaluated the number of articles published and their mean journal impact factor. We also studied the research productivity of various areas adjusted for gross domestic product (GDP) and population. We found that Western Europe leads the world in published research on infectious diseases–microbiology (82 342 articles [38.8%]) and in cardiopulmonary medicine (67 783 articles [39.5%]), whereas the United States ranks first in the fields of preventive medicine, public health and epidemiology both in quantity (23 918 articles [49.1%]) and quality of published papers. However, after adjustments for GDP, Canada ranked first, with the United States and Oceania following closely behind. All of the developing regions had only small research contributions in all of the biomedical fields examined.

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Several investigators have conducted bibliometric analyses of research productivity of different world regions. However, comparisons between research output in different scientific disciplines are limited because of the different methodologies used.<sup>1–3</sup> Also, not many researchers have looked at the association between potential predictors of scientific output and their interaction with geographic and population characteristics. Over the past 3 years, we have conducted a series of bibliometric analyses of several biomedical fields, including the evaluation of specific regions around the world during a 9-year period (1995–2003).<sup>4–11</sup> In this paper, we present a comparative analysis of the research productivity of the 9 specified regions<sup>4–11</sup> in 3 broad scientific disciplines: infectious diseases–microbiology (using the Institute for Scientific Information<sup>12</sup> [ISI]’s fields for infectious diseases, microbiology, virology, parasitology, tropical medicine and mycology), cardiopulmonary diseases (including the cardiac and cardiovascular systems, respiratory and critical care medicine ISI fields) and preventive medicine–public health (including the preventive, occupational and environmental medicine, public health and epidemiology ISI fields).

The methodology we used has been described in previous

publications.<sup>4–11</sup> In order to present a comparative analysis of all of the fields for the same 9-year period (1995–2003), we collected additional data for the fields of infectious diseases and cardiac and cardiovascular systems for 2003 (our published work included the periods of 1995–2002 for the above 2 fields). The research productivity of each international region was further evaluated in relation to the population and gross domestic product (GDP) in standard 1995 US dollars, as provided by the World Bank.<sup>13</sup>

In Table 1 we present the scientific output from regions around the world. A large proportion of the data on the productivity of the various regions in specific research fields has already been published.<sup>4–11</sup> When we added up the total published articles in all 3 broad scientific disciplines, multiplied by the impact factor of the individual journals in each broad category and then adjusted for the GDP of each region, Canada ranked first (total product per GDP 827), the United States ranked second (total product per GDP 639) and Oceania ranked third (total product per GDP 626).

Based on our findings, Canada had the highest research productivity (after adjusting for GDP) in most of the biomedical fields examined. Canada ranked first in the field of cardiopulmonary medicine and second in the other 2 broad categories analyzed. Also, after adding up the total product of all 3 broad categories examined and adjusting for GDP, Canada ranked first. These findings can be attributed to several factors, including the priority that has been given to research and characteristics of the academic environment in Canada. Oceania also ranked very highly in all categories when the same adjustments were made, and was closely behind the United States after adding up the total research published. Although Canada and Oceania represent positive examples of research productivity, absolute unadjusted indices may offer a different impression.

The United States leads the world in research in the fields of preventive medicine, occupational and environmental medicine, public health and epidemiology. This is not surprising, given that these areas of study have been given priority in the United States. On the other hand, researchers in Western Europe published more articles than those in the United States in the cardiopulmonary fields, as well as in 4 of the 6 infectious diseases–microbiology fields (i.e., microbiology, parasitology, tropical medicine and mycology). These findings may be explained by the long tradition of research in cardiopulmonary

**Table 1:** Worldwide research productivity in several biomedical fields, 1995-2003\*

Area‡	Population‡	GDP‡	No. of articles, mean impact factor, total product per population, total product per GDP†															
			Infectious diseases-microbiology				Cardiopulmonary diseases				Public health-epidemiology				Total			
Canada	31	6.026	6503	3.1	665	337	8449	3.1	853	432	1956	1.8	115	58	16 908	3.0	1633	827
United States	282	76.730	68 928	3.5	855	315	63 144	3.2	716	263	23 918	2.0	166	61	155 990	3.1	1737	639
Oceania	30	4.674	6273	2.7	548	358	3929	2.7	345	225	1194	1.8	69	45	11 396	2.6	962	626
Western Europe	389	89.804	82 342	2.8	595	257	67 783	2.5	441	191	15 740	1.5	61	27	165 865	2.6	1097	475
Africa	779	4.888	6126	1.8	14	226	877	1.8	2	33	571	1.5	1	18	7574	1.8	17	276
Eastern Europe	421	9.862	5146	1.7	21	88	4082	1.4	14	59	771	1.2	2	9	9999	1.5	37	156
Asia	3387	32.086	13 535	2.1	8	88	7629	2.1	5	49	2452	1.4	1	10	23 616	2.0	14	147
Japan	127	50.423	13 234	2.3	244	61	13 783	2.7	292	73	1393	1.3	14	4	28 410	2.5	550	138
Latin America	504	16.751	10 332	1.7	34	102	1880	2.3	9	26	686	1.7	2	7	12 898	1.8	45	136
Total	5950	291.244	212 419	2.9	102	208	171 556	2.8	80	163	48 681	1.7	14.2	29	432 656	2.7	196	399

Note: GDP = gross domestic product.

\*The analysis includes articles published (1995-2003) in journals indexed by the Institute for Scientific Information in the fields of infectious diseases-microbiology (infectious diseases, microbiology, virology, parasitology, tropical medicine and mycology), cardiopulmonary diseases (cardiac and cardiovascular systems, respiratory medicine and critical care medicine) and public health-epidemiology (preventive, occupational and environmental medicine, public health and epidemiology).

†Total product is defined as the sum of the number of articles published multiplied by the impact factor of the individual journals of each broad category. The average population and total GDP (in 1995 US dollars) of the world areas examined during the study period were used in the analysis.<sup>3,7</sup> Total product per population and total product per GDP of the various areas refer to number of articles multiplied by journal impact factor per million people and per ten trillions of 1995 US dollars, respectively.

‡The geographic areas were ranked in descending order based on their total research product (in the 3 broad categories analyzed) adjusted for GDP (last column of the table). Latin America includes the Caribbean. Asia does not include Japan, for which there are separate data. The average population of the geographic areas during the study period is presented in millions. GDP is the total GDP of each area for the study period (in trillions of 1995 US dollars).

medicine and infectious diseases-microbiology in Europe. Unfortunately, the developing regions of the world contribute a very small amount of research to the worldwide biomedical research output. What is even more worrisome is that developing countries are low on the list of research productivity even after adjusting for GDP. Our analysis does have limitations in the interpretation of all of the results, as described in our original bibliometric papers.<sup>4-11,14</sup>

In summary, the fact that the scientific production of researchers in Canada is higher (when adjusted for GDP) compared with other regions around the world deserves careful attention by the worldwide scientific community, as well as by public and private funding organizations, to identify the key determinants contributing to the cost-effective research productivity of this country.

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