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the tobacco industry operates in similar ways throughout the world, much can be achieved through sharing of information across national boundaries. All EU governments are expected to have ratified the WHO Framework Convention on Tobacco Control by the end of 2005. The world's first public health treaty commits governments to take action to reduce the disease, disability, and death caused by tobacco. The evidence based policies that it contains—such as increases in tobacco tax, advertising bans, smoke-free public places, and hard hitting picture warnings—have been proved to work. It's time for Europe's doctors to treat tobacco dependence in their patients. But it's also time to move out of the consulting room and demand that our governments take effective action too.

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Comparison of amount of biomedical research originating from the European Union and the United States

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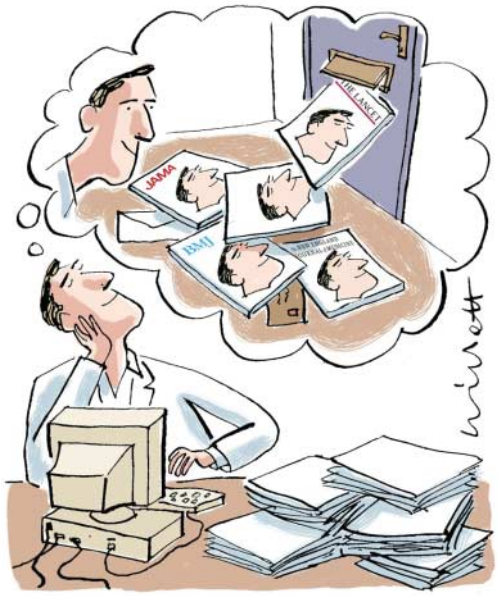
Abstract

Objective To examine and compare the research productivity of the European Union, the four "candidate" countries (those currently waiting to join the EU), and the United States in several fields of biomedical sciences.
Design A retrospective observational study—bibliometric analysis.
Data sources Manuscripts published by authors from each country separately and from each group of countries for the period 1994 to 2004 and included in the Essential Science Indicators database of the Institute of Scientific Information.
Main outcome measures Number of published articles and number of citations, adjusted for gross domestic product and population size.
Results 1 485 749 articles were published by authors from the EU compared with 1 356 805 from the US. The research productivity of the first 15 countries to join the EU, adjusted for population, was lower (76%) than that of the US—and even lower (66%) when the 10 newest EU countries were included in the analysis.
Conclusion The newest EU members and the EU candidate countries need further help and resources to increase their productivity, thereby improving the productivity of the EU as a whole.

The European Union and the United States are the leading powers in biomedical research and publications, although the US is ahead of the EU in most scientific disciplines.[1 2] The EU has been gradually closing this gap, but the union's future expansion might widen the gap again in favour of the US.[3 4] We examined the biomedical research output of the EU's member countries and of four candidate countries for the EU, to compare the geographical distribution of output across Europe with the output in the US.

Methods

Our study covered the period 1994 to 2004. We examined data for the US plus three groups of European



countries: *(a)* the first 15 states joining the EU (including three—Austria, Finland, Sweden—that did not join until January 1995); *(b)* the 10 countries that joined the EU in May 2004; and *(c)* the four "candidate" countries waiting to join (Bulgaria, Croatia, Romania, Turkey). We estimated the amount of research produced by each country separately and by each group, using the information included in the Essential Science Indicators database of the Institute for Scientific Information. A paper was attributed to any country (or countries) if an address for that country was given by one or more authors; therefore an article could be attributed to more than one country.

We focused our search on nine scientific fields: biology and biochemistry; clinical medicine; immunology; microbiology; molecular biology and genetics; multidisciplinary; neuroscience and behaviour; psychiatry and psychology; and pharmacology and toxicology.

We used the online World Bank database to retrieve information on the average population size, the mean gross domestic product, and percentage of gross domestic product devoted to research and development.[5]

Results

We identified 1 485 749 articles published by authors from the European Union and the four candidate countries and 1 356 805 articles published by US authors. In the table we present raw and adjusted indicators for each country (adjusted for population size, gross domestic product, and percentage of gross domestic product devoted to research and development) and the average indicators for the different subgroups and the US. The research productivity for the group of original 15 member states of the EU, adjusted for population, was three quarters (76%) of the productivity of the US, but when the 10 newest members were also included, EU productivity declined to 66%, and when the four candidate countries were also included, EU productivity reduced further, to 55%. However, after adjustment for funds devoted to research and development, the number of published articles from the 25 EU member states plus the candidate countries is much higher than the number of published articles from the US.

Biomedical research productivity in Europe and United States, 1994-2004

Countries	Average population (millions)	Average GDP ($bn)	Average % of GDP for R&D	No of papers	No of citations	No of scientific fields covered	Papers per 1000 population	Papers per $bn	Papers per $bn for R&D	Citations per 1000 population	Citations per $bn
EU-15											
Austria	8	255.8	1.8	34 367	371 988	9	4.3	134	747	46.5	1454
Belgium	10.2	300.6	1.9	46 218	596 719	9	4.5	154	809	58.4	1985
Denmark	5.3	197.3	2.0	37 297	497 486	9	7	189	944	93.7	2522
Finland	5.2	151.4	3.0	35 498	477 656	9	6.8	234	782	92.6	3156
France	5.6	1 687.40	2.2	197 103	2 311 762	9	3.4	117	531	39.5	1370
Germany	82.1*	2590.00*	2.4	273 235	3 201 982	9	3.3	105	439	39	1236
Greece	10.5	132.4	0.6	16 840	108 057	9	1.6	127	2132*	10.3	816
Ireland	3.7	92.4	1.2	11 453	121 980	9	3.1	124	1031	32.5	1321
Italy	57.5	1166.70	1.0	142 179	1 536 621	9	2.5	122	1218	26.7	1317
Luxemburg	0.4	22.5	Not available	474	4588	7	1.1	21	Not available	10.7	204
Netherlands	15.8	467.2	2.0	95 152	1 250 423	9	6	204	1019	79.3	2677
Portugal	10.1	121.8	0.7	7732	64 647	9	0.8	63	909	6.4	531
Spain	40.1	662.4	0.9	80 899	688 465	9	2	122	1357	17.2	1039
Sweden	8.9	274	4.0	78 426	1 042 495	9	8.8*	286*	716	117.6*	3806*
United Kingdom	58.7	1.252.60	1.9	337 969*	3 878 795*	9	5.8	270	1420	79.5	3726
EU-10											
Cyprus	0.7	10	0.2	141	1739	4	0.2	14	705	2.3	174
Czech Republic	10.3	54.7	1.2	10 775	70 140	9	1	197	1632	6.8	1283
Estonia	1.4	4.9	0.6	1670	13 269	9	1.2	340*	5566*	9.6	2703*
Hungary	10.1	51	0.7	12 289	100 213	9	1.2	241	3414	9.9*	1966
Latvia	2.4	5.8	0.4	342	3187	7	0.1	59	1710	1.3	548
Lithuania	3.5	8.7	0.6	942	8060	8	0.3	108	1884	2.3	928
Malta	0.4	3.7	Not available	7	63	1	0	0.2	Not available	0.2	17
Poland	38.6*	131.6*	0.7	20 572*	122 053*	9	0.5	156	2236	3.2	928
Slovakia	5.4	22.2	0.8	5755	27 756	9	1.1	260	3197	5.2	1252
Slovenia	2	21.7	1.5	3365	19 691	8	1.7	155	1020	9.9*	907
EU-CCs											
Bulgaria	8.2	12.4	0.6	3531	14 861	8	0.4	285*	5044*	1.8	1199*
Croatia	4.5	21.6	0.6	3794	18 107	9	0.8*	175	2918	4*	837
Romania	22.5	34.5	0.5	1325	8538	9	0.1	38	779	0.4	247
Turkey	65.7*	192.2*	0.5	26 399*	197 240*	9	0.4	137	2750	3	1026
Totals											
EU-15	375.1	9374.5	1.9	1 394 842	16 153 664		3.72 (0.8-8.8)†	149 (21-286)†	764	43.1 (6.4-117.6)†	1723 (204-3806)†
EU-10	74.8	314.3	0.82	55 858	366 171		0.75 (0.02-1.7)†	178 (0.2-340)†	2173	4.9 (0.2-9.9)†	1165 (17-2703)†
EU-CCs	101.0	260.7	0.51	35 049	238 746		0.35 (0.1-0.8)†	134 (38-285)†	2635	2.4 (0.4-4.0)†	916 (247-1199)†
EU-25	450.0	9688.8	1.9	1 450 700	16 519 835		3.2	150	784	36.7	1705
EU-25 plus EU-CCs	551.0	9949.5	1.9	1 485 749	16 758 581		2.7	149	797	30.4	1684
US	278.4	8930.50	2.7	1 356 805	23 801 368	9	4.9	152	563	85.5	2665

GDP=gross domestic product.
EU-15=first 15 members of the European Union.
EU-10=next (latest) 10 countries to join the European Union (1 May 2004).
EU-CCs=candidate countries (those waiting to join the European Union).
EU-25=EU-15 plus EU-10.
*First ranking country in each group and in each column.
†Range in parentheses.

Discussion

The original 15 EU states have some of the strongest publication records, and their ranking individually within that group changes depending on the indicator used. For example, raw numbers favour the United Kingdom, Germany, France, and Italy (the four most populous countries), whereas adjusted indicators favour the Scandinavian countries and the Netherlands. The research productivity of many of the original member countries, adjusted for population size or for funds devoted to research and development, far exceeds the productivity of the US, but productivity for the EU as a whole, adjusted for population, is only two thirds that for the US. Furthermore, some of the 10 newest EU states (Slovenia, Hungary, Estonia, and the Czech Republic) have higher indicators than the lowest ranking countries of the original 15 EU states. The four candidate countries, in general, have lower indicators than the 10 newest EU states, with the exception of publications per billions of US dollars devoted to research and development, where they rank higher.

The negative geographical gradient from north to south and west to east, evident by other indicators, is also present in the biomedical research within the European Union.[6] Although the US leads the biomedical research race by most indicators, the original group of 15 EU states as a whole was not far behind. Moreover, US based journals are more heavily represented than European journals in the Institute for Scientific Information's databases,[7] therefore affording the US an advantage not adjusted for in our comparison. However, the accession of the 10 newest EU states resulted in a substantial dilution of research indicators and a considerable increase in the publication gap in relation to the US, which is due to worsen with the planned accession of candidate countries, excluding the indicator adjusted for funds devoted to research and development.

Given the importance of biomedical research in economic development, we urge the EU governing bodies, along with the scientific community, to further strengthen research networks of excellence in the EU and continue to increase funding opportunities in biomedical research (as has happened with the sixth framework programme in support of research in the EU and the candidate countries, as well as in some eastern European countries not in the EU).[8] Furthermore, the newest EU members and the candidate countries need particular attention to increase their research productivity and improve their indicators, thus raising productivity for the EU as a whole.

What is already known on this topic

The European Union and the United States are the leading powers in biomedical research and publications, although the US is ahead of the EU in most scientific disciplines

The EU has been gradually closing this gap, but the union's future expansion might widen the gap again in favour of the US

What this study adds

Research productivity for the EU as a whole, adjusted for population, is only two thirds that for the US and may dip further in relation to the US once the four candidate countries join the union

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Commentary: Bridging the gaps in biomedical research

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Soteriades and Falagas[1] and Burazeri and colleagues[2] explored the distribution of quality research on either side of the Atlantic and in southeastern Europe. The well known North-South and West-East divides re-emerged. The authors emphasise the negative influence that the accession of the new member states will have on the total scientific output of the European Union, as well as the greater productivity of US authors that already exists.

Science is the environment of different traditions that are unequally distributed among countries and cultures. Historically, its development is deeply rooted in social and cultural processes and often imbued with aspects of power, authority, and control. Totalitarian dictatorships provided us with a variety of examples, but democracies provided some examples as well. Reflecting on how science was transformed through the mediation of unequal power relations is necessary if we are to attempt to rethink strategies for bridging the existing gaps in biomedical research.

Political and economic experiences are a structural part of modern knowledge. We can hardly discuss knowledge or science without considering the political and economic dimensions of their emergence and use. The West-East and North-South gradients in scientific output are surely related to availability of resources,