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Institutional operating figures in basic and applied sciences: Scientometric analysis of quantitative output benchmarking

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Abstract

Background: Institutional operating figures and benchmarking systems are important features for the implementation of efficacy in basic and applied sciences. They are needed for research evaluation and funding policy. However, the current policy settings for research evaluation urgently need review since there may be imbalances present in many areas.

Methods: The present study assessed benchmarking of research output. By the use of large data bases research output was categorized and analyzed. Specific areas of major research activity were identified by comparing publication density on different organ systems and inter- and intrafield comparison was performed for selected countries.

Results: Novel density-equalizing mappings were constructed that illustrate trends of publication activity and identify subsets of major interest in a total of 5,527,558 published items. A dichotomy was present between Western countries such as the US, UK or Germany and Asian countries such as Japan, China or South Korea concerning research focuses.

Conclusion: The present study is the first large scale analysis of global research activity and output over the last 50 years. The presently described assessment of operating figures at the national and international level can be used to identify single areas of research that are heavily focused. Further research on qualitative output benchmarking is needed to improve current policy settings for research evaluation.

Background

Economic progress is crucially dependent on advance in basic and applied research. The advance itself is directly related to intramural and even more to extramural governmental and non-governmental funding. Due to the importance of external funding for the advance of science, numerous statements [1-9], reviews [10,11] and original studies [12] exist that focus on funding trends. Also evaluation policies by major funding organizations are published annually. Due to the tight financial situation in many countries it is becoming increasingly difficult to provide solid monetary resources for both research and

education. Therefore, acquisition of extramural grants from governmental and non-governmental institutions has become indispensable for all fields of research. In this respect, institutional operating figures and benchmarking systems are extremely important features to implement efficient funding. While tools to assess these features are known for many areas of research they are especially important in biomedical research. Here they are used to analyze funding schemes and to develop future funding policies. There is a remarkable amount of scientific literature present on institutional operating figures for biomedical areas which are heavily funded by governmental or industrial sponsors. These areas are i.e. neuroscience [13], cardiovascular medicine [14], gastroenterology [15], immunology [16], genetics [17], molecular biology [18-20] or stem cell research [21-23]. Next to the existing literature for these major fields of research there are also data available for smaller areas such as history of medicine [24], medical education [25], nursing sciences [26,27], reproductive health [28] or rehabilitation sciences [29,30].

Reviewing the existing policy in Europe [31] and general statements [32-36], it becomes clear that institutional operating figures and benchmarking systems are needed for research evaluation and funding policy.

The present study was performed to establish a first overview on global publication activities as a benchmark of quantitative research output. Due to the existence of multiple and advanced data bases, the area of biomedical research was chosen and publications related to single organs/systems were analyzed.

Methods

Using two large databases (Scopus and Web of Science), biomedical research output was categorized with the numbers of published entries as an index marker for quantity of output. Quantities were analyzed with regard to three main characteristics: 1) organs 2) countries 3) publication dates. The below listed data bases were used.

Scopus

This is the largest abstract and citation database of research literature and quality web sources. It is designed to find the information scientists need. Quick, easy and comprehensive, Scopus provides superior support of the literature research process. Updated daily, Scopus includes: Over 15,000 peer-reviewed titles from more than 4,000 publishers (500 Open Access journals, 700 conference proceedings, 600 trade publications), 29 million abstracts, 265 million references. The Scopus data base was used to construct charts with organ-country-specific publication benchmarks.

Web of Science

This is an online academic database provided by the Thomson Institute for Scientific Information (ISI, license with Charité, Humboldt-University Berlin) [37,38]. It provides access to many databases and other resources including: Science Citation Index (SCI), Social Sciences Citation Index (SSCI), Arts & Humanities Citation Index (A&HCI), Index Chemicus, and Current Chemical Reactions, covering about 8,700 leading journals in science, technology, social sciences, and humanities.

Search strategies

For the different searches, the following terms joined together with Boolean operators, i.e. AND were used:

1) organs – the following terms were used to identify single organs: Brain, heart, artery, vein, lung, muscle, eye, nose, ear, throat, neck, skin, breast, stomach, intestine, pancreas, kidney, genital, hormone, arm, feet.

2) countries – while the search in the Web of Science was not restricted in order to calculate global density – equalizing maps, the Scopus searches were restricted to the following list of countries: United States, Germany, Japan, United Kingdom, Iran, Singapore, New Zeeland, Egypt, South Africa, Greece, Mexico, Hungary, Norway, Brazil, Turkey, South Korea, Israel, Austria, Taiwan, Spain, Poland, Belgium, Russia, Switzerland, Sweden, Australia, Netherlands, India, France, Italy, Canada, China.

3) Time span – the analyzed time spans are listed for each data set in the result section: Figure 1, 2, 3, 4: Scopus – all data base files included until the date of the retrieval (2007-09-30). Figures 5, 6, 7, 8, 9: Web of Science – data included between 1966 – 1976 and 1996 – 2006 (2007-11-12). Additional file 1: Scopus – data included between 1961–1970, 1971–1980, 1981–1990, 1991–2000, 2001–2007 (decade 2000–2010 not finalized) (2007-09-30).

Total numbers of entries were also related to the parameters gross domestic product (GDP, supplied by the international monetary fund [39], Figure 2) and population numbers of 2007 (supplied by CIA World fact book [40], Figure 2).

Density-equalizing mapping

Density-equalizing mapping was used for visualization of data according to a recently published method. In brief, territories were re-sized according to a particular variable, i.e. the number of published items. For the re-sizing procedure the area of each country was scaled in proportion to its total number of published items regarding the organs heart, brain, liver, lung and skin. The specific calculations are based on Gastner and Newman's algorithm [41]. As data set, published items for each organ between

Country	Brain	Eye	Nose	Ear	Throat	Neck	Skin	Breast	Heart	Artery	Vein	Lung	Stomach	Intestine	Liver	Pancreas	Kidney	Genital	Hormone	Arm	Feet	Muscle	Total
United States	230678	72524	10994	20882	3634	33623	105022	76188	241963	128843	44780	148504	29751	39818	154753	29870	122465	10843	145143	34840	22692	185990	**1.893.800**
Japan	66962	24261	3256	6412	1048	9176	30723	10320	58277	46548	17993	44881	24223	13853	68264	12960	33653	1905	30516	8234	4120	55888	**573.473**
Germany	47843	16354	3326	5517	947	8026	31372	13171	59754	33116	13290	31347	10670	9534	37522	9704	30918	2776	27534	8316	4463	39275	**444.775**
United Kingdom	44044	16057	3595	5274	1364	7541	28573	19292	50387	24360	10836	30604	9385	12000	30712	5913	22589	3327	32818	9616	6023	41189	**415.499**
France	32294	7504	1932	2974	606	4832	19969	11585	33255	20631	9665	22826	6186	7889	27380	6164	19197	2790	25557	5911	3055	25323	**297.525**
Italy	26198	6410	1823	2187	407	4642	16457	11775	33095	17372	7076	19192	7509	5147	24345	4555	15368	1773	20074	4995	2558	20861	**253.819**
Canada	29035	7197	1265	2122	444	3386	9690	8433	27987	13771	5941	17567	3619	5265	17284	3104	12596	1203	17149	5694	2442	27314	**222.508**
Netherlands	11974	4587	856	1441	330	2585	8452	4928	17262	10098	3411	9514	2200	2864	9837	1666	7812	647	9889	3341	1495	11937	**127.126**
Sweden	13622	3267	1244	1897	364	2361	7064	4412	13132	7100	3301	7391	2986	3804	9302	3840	7104	941	10227	2361	1103	13553	**120.376**
Australia	11006	5576	688	1700	374	2414	7966	5028	12690	6794	3338	7459	2441	3068	8899	1442	7267	917	9663	3054	1628	13683	**117.095**
Spain	12688	3322	777	1189	208	2128	7522	4179	11357	6030	3050	7843	2666	2629	12581	1988	8591	792	8642	2204	1202	8588	**110.176**
China	11496	5174	714	1385	541	1834	5472	2966	10475	8104	4783	8286	3661	1833	12973	1426	4695	322	3975	3197	1197	9162	**103.671**
Switzerland	10767	3831	649	993	202	1598	6345	2963	10075	6668	2975	6514	1737	2116	7060	2145	6191	511	6603	1893	1143	8045	**91.024**
India	7300	3492	812	942	329	1731	6705	2450	6967	3334	1741	4636	1754	2352	10220	926	5196	816	4728	1496	1410	4883	**74.220**
Belgium	6262	1694	605	929	163	1328	4340	2787	8314	4754	1964	5828	1539	1588	6314	2156	4719	482	6525	1552	750	7066	**71.659**
Israel	7382	2710	434	1052	153	1305	4657	2824	9832	4831	1725	3960	893	1484	4473	871	4155	439	6284	1163	805	5845	**67.277**
Poland	6630	1607	480	711	130	850	4166	1699	7784	4096	1464	4225	2148	1471	5641	1150	4220	383	4383	855	602	4854	**59.549**
Russia	7706	1347	289	413	61	389	2716	844	9088	2820	1045	5953	2534	2157	6768	1034	3341	216	3183	287	235	6479	**58.905**
Austria	5542	2183	363	722	103	1179	4417	2168	6969	4938	2175	4187	1152	1094	5041	771	3623	337	3251	1059	665	4585	**56.524**
Turkey	3964	2127	629	943	220	1608	3832	1717	5904	5741	1965	3325	1140	991	4158	498	3717	511	2754	928	738	4031	**51.441**
Taiwan	4133	1679	344	617	201	1478	3152	1288	4928	3504	1775	3469	1313	819	5500	492	2425	195	1922	1112	640	3862	**44.848**
Brazil	206	48	550	837	130	1034	4045	1694	6342	2991	1342	2664	1222	1194	3742	546	2936	459	2999	1269	743	5094	**42.087**
South Korea	4127	1392	431	618	123	1026	4315	1232	2428	2550	1184	3874	1538	778	4369	572	3193	178	1626	1268	530	3310	**40.662**
Norway	2962	886	273	413	124	722	2207	1669	5438	2470	1029	2283	1328	1050	3512	544	1861	249	2240	584	302	3470	**35.616**
Hungary	3633	874	134	291	29	429	1395	750	3094	1743	631	1556	885	720	2453	571	1893	151	2770	386	213	3030	**27.631**
Greece	1710	861	130	261	69	700	1567	1603	3327	2344	739	2025	611	518	2157	376	1396	197	2004	715	245	1887	**25.442**
Mexico	3012	852	248	317	78	423	1802	943	3145	1268	565	1681	500	559	2176	287	1346	391	2351	702	313	2096	**25.055**
New Zealand	1861	694	159	271	74	380	1351	894	3049	1114	609	2798	471	472	1415	204	1291	148	2094	501	269	1987	**22.106**
South Africa	1307	582	139	256	62	427	1378	776	3073	1230	601	1623	715	479	1830	402	1165	226	1311	403	322	1691	**19.998**
Singapore	1137	775	125	148	79	385	1126	587	1179	692	261	773	269	200	1099	151	564	114	598	433	180	930	**11.805**
Egypt	471	351	138	198	47	272	803	345	646	333	285	376	196	284	1579	80	833	147	645	164	104	880	**9.177**
Iran	518	332	83	97	49	180	747	278	603	407	183	389	173	156	549	56	618	64	390	239	95	505	**6.711**
Total	**618470**	**200550**	**37485**	**64009**	**12693**	**99992**	**339348**	**201788**	**671819**	**380595**	**151722**	**417553**	**127415**	**128186**	**493908**	**96464**	**346938**	**34450**	**399848**	**108772**	**62282**	**527293**	**5.521.580**

Figure 1
Total number of published items.

1966 – 1976 and 1996 – 2006 of the ISI Web data base were used.

Results

Total number of published items

Using the Scopus database, the number of published items was used as a benchmark of quantity of research output. A total of 5,527,558 published items were analyzed and large differences were found between single organs and single countries (Figure 1): The United States was found to be the most productive country with a total number of 1,893,800 published items. Japan ranked second with 573,473 items followed by Germany (444,775) and the United Kingdom (415,499). When the total number of published items is related to the gross domestic product (GDP) the ranking changes and Israel (1.), Sweden (2.), Hungary (3.), Switzerland (4.) and New Zealand (5.) are listed in the first positions (Figure 1). In this score, the US (14.), Japan (17.), Germany (13.) and UK (11.) are listed in later positions. When the total number of published items per country is related to the number of inhabitants, the first positions include Sweden (1.), Switzerland (2.), Israel (3.), Netherlands (4) and Norway (5.) while the US (10.), Japan (15.), Germany (13.) and UK (7.) are listed in later positions. (Figure 2).

Country-specific output

When the different organs are related to the most productive countries, an apparent trend is seen for all organs that were analyzed in the present study (Figure 3): The most productive country for every organ is the United States. Then, Japan, UK and Germany follow on the second place. Color-coding demonstrates for the top ten countries that there is a similar country-specific ranking present for many countries. I.e. France is ranked number 5 in 18 out of 22 organ categories and Italy is ranked number 6 in 14 out of 22 organ categories.

Further detailed analysis on the organ-specific research output of different countries using 5 separate time spans from 1961–1970, 1971–1980, 1981–1990, 1991–2000 and 2001–2007 creates a vast amount of information [Additional file 1]. However, it demonstrates the same tendencies for each of these decades with no or only minor exceptions.

International differences in focus of research

A remarkable difference is present in the individual focus of each country analyzed in the Scopus database. The United States has a clear ranking with the primary focus on studies related to heart (1), brain (2), Muscle (3), liver (4) and lung (5) (Figure 4). A similar focus is shared by countries such as the United Kingdom, Germany or Switzerland with an identical top 3 as indicated by color coding (Figure 4). However, the second most productive country Japan has its primary focus on articles related to the liver. Countries that also primarily focus on the liver are China, Taiwan, South Korea, India and Egypt (Figure 4).

A second step in analyzing international differences is to assess the research output activity over different time

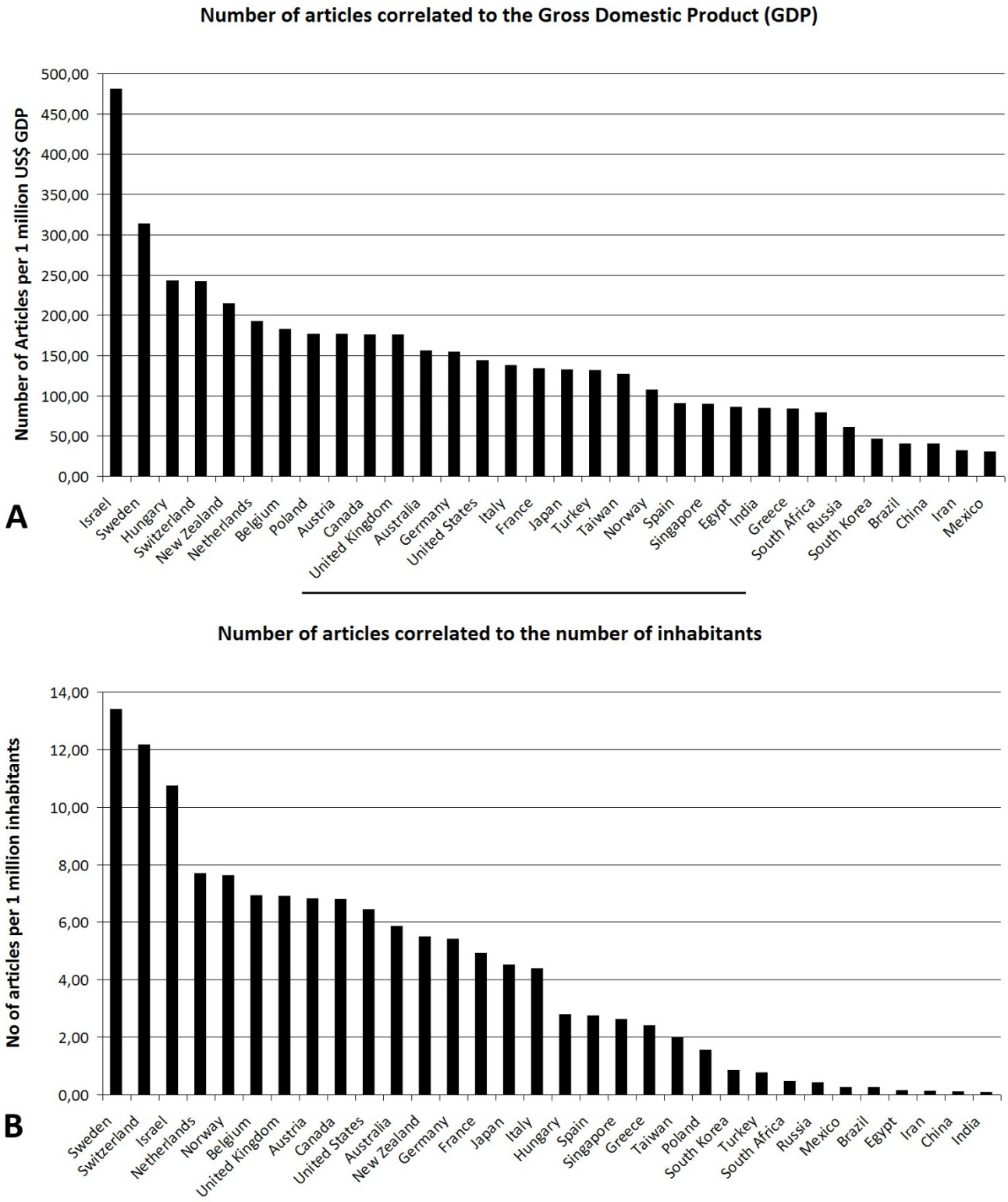

Figure 2
Total number of published items in relation to the gross domestic product (GDP, A) and to the number of inhabitants (B). Scopus data base search.

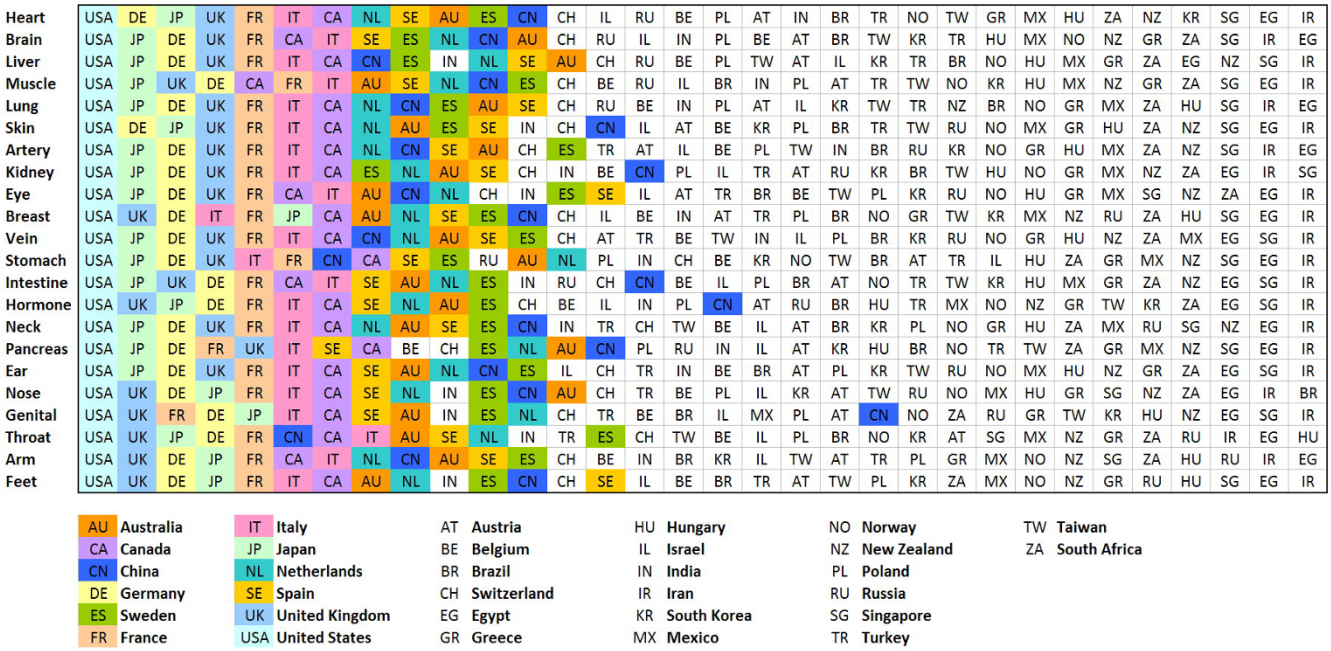

Figure 3
Organ-specific and country-specific ranking of published items. Scopus data base search.

spans. The Additional file 2 shows the productivity development (published articles) of each country for every of the 22 organs between 1961–1970, 1971–1980, 1981–1990, 1991–2000 and 2001–2007. Strong increases in quantitative output are present for most countries and most organs [Additional file 2].

Density-equalizing mapping

In a final step, a Web of Science analysis encompassing all countries and density equalizing algorithms were used to visualize global trends in quantitative research output. The two periods 1966–1976 and 1996–2006 were analyzed for the organs heart, brain, liver, lung and skin and

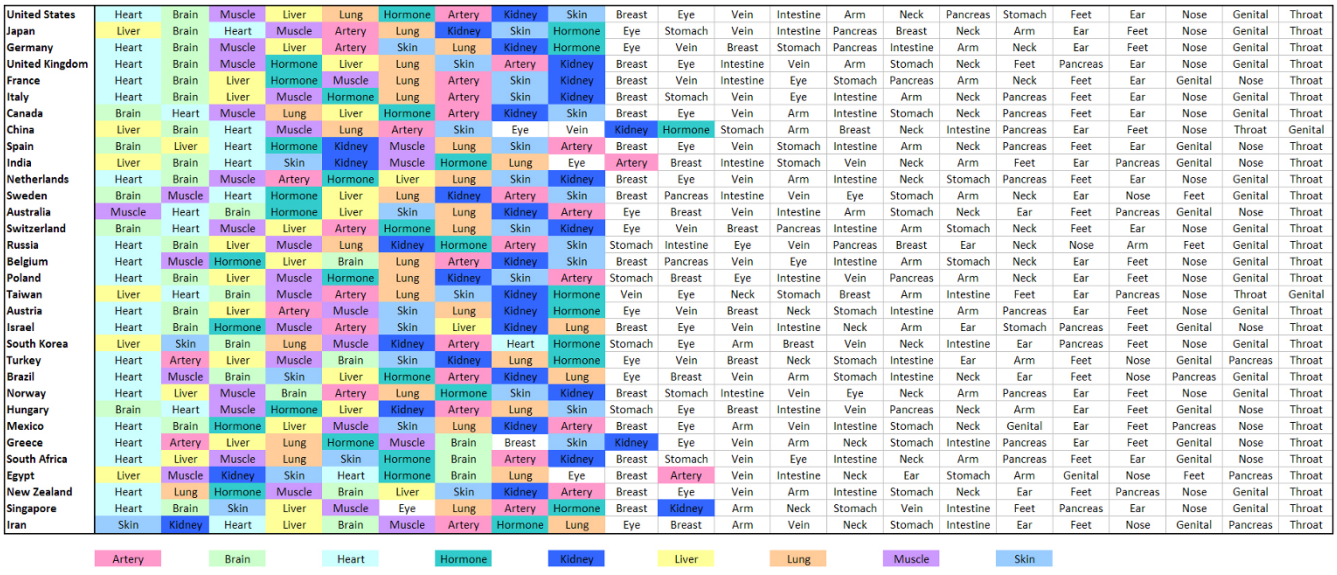

Figure 4
International differences in focus of research. Ranking of organs in each country. Scopus data base search.

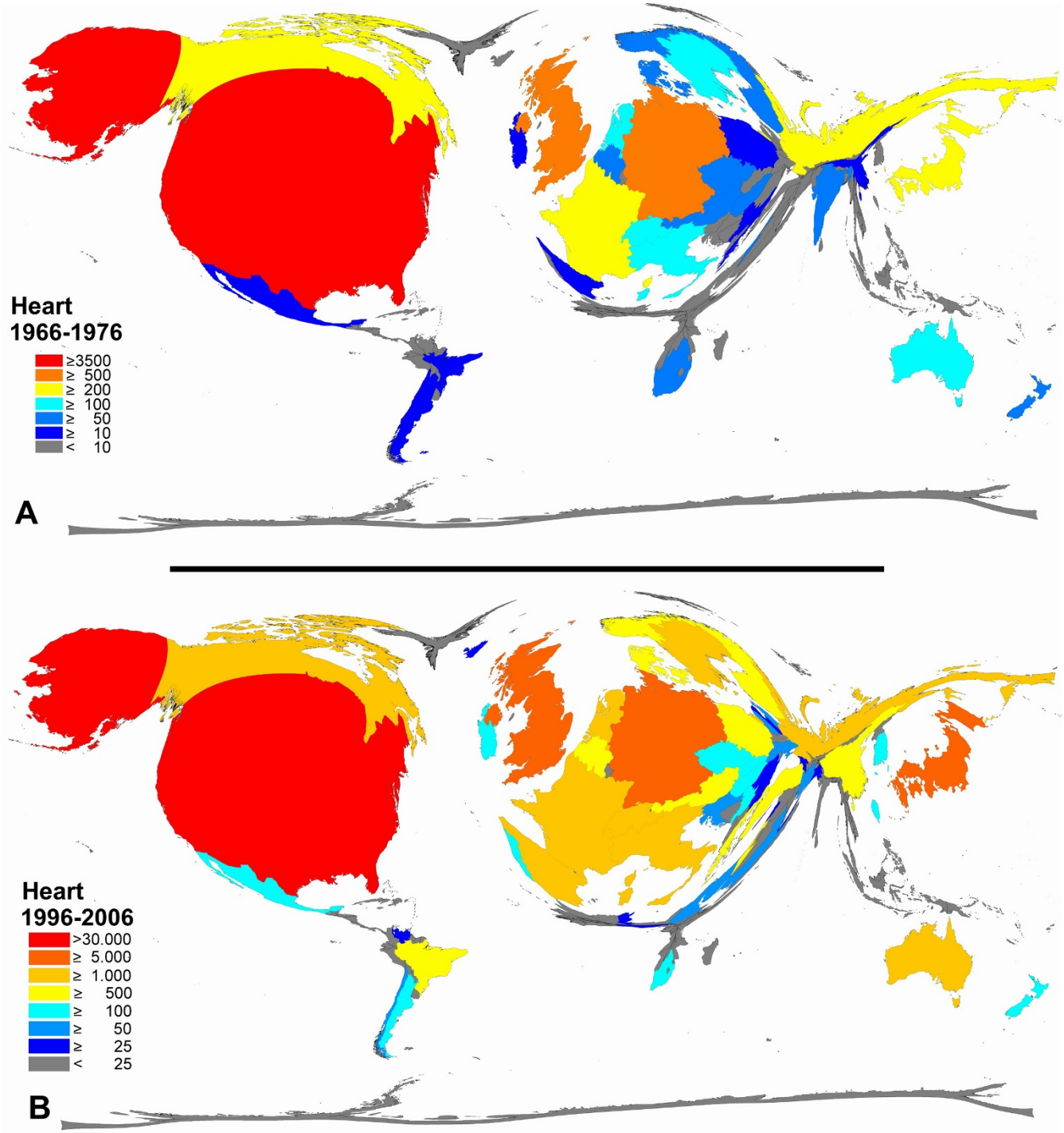

Figure 5
Color-coded Density-equalizing mapping: Publication quantities for items related to the term "heart" in the two periods 1966–1976 and 1996–2006. Web of Science data base search.

transferred to cartograms. Color-graduation shows that there is a large difference in the overall number of published items related to the heart (Figure 5) with a factor of about 10 between the periods of 1966–1976 and 1996–2006. The proportion of the leading countries is similar in both periods. Only minor proportional changes can be found, i.e. for Brazil (increase) versus Argentina or India (decrease) versus China or Spain (increase) versus France.

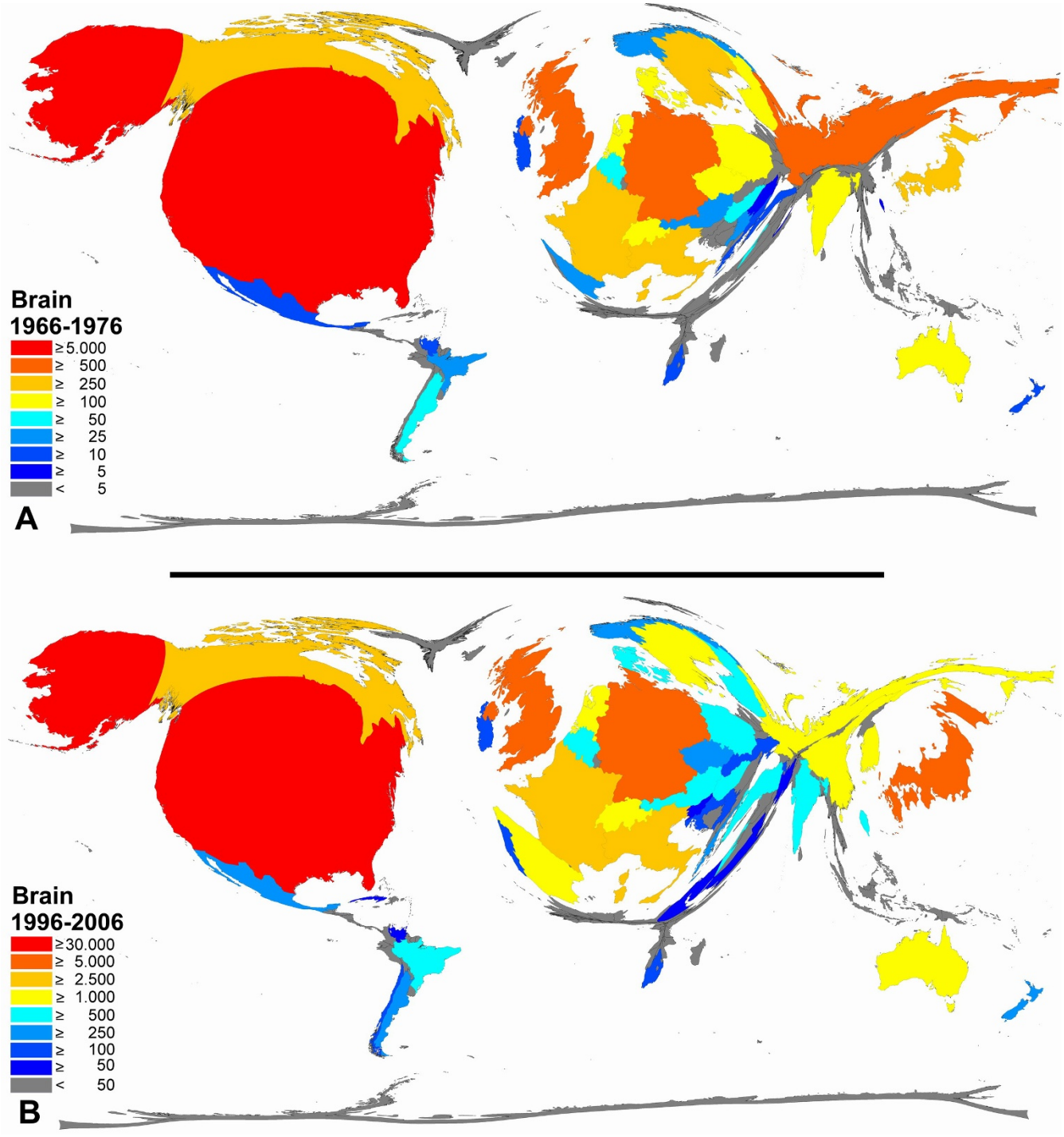

Figure 6
Color-coded Density-equalizing mapping: Publication quantities for items related to the term "brain" in the two periods 1966–1976 and 1996–2006. Web of Science data base search.

When focusing on the published items related the brain similar trends can be seen with a relatively stable situation for the top productive countries US, UK, Japan and Germany and small increases for countries such as China, Spain or South Korea (Figure 6).

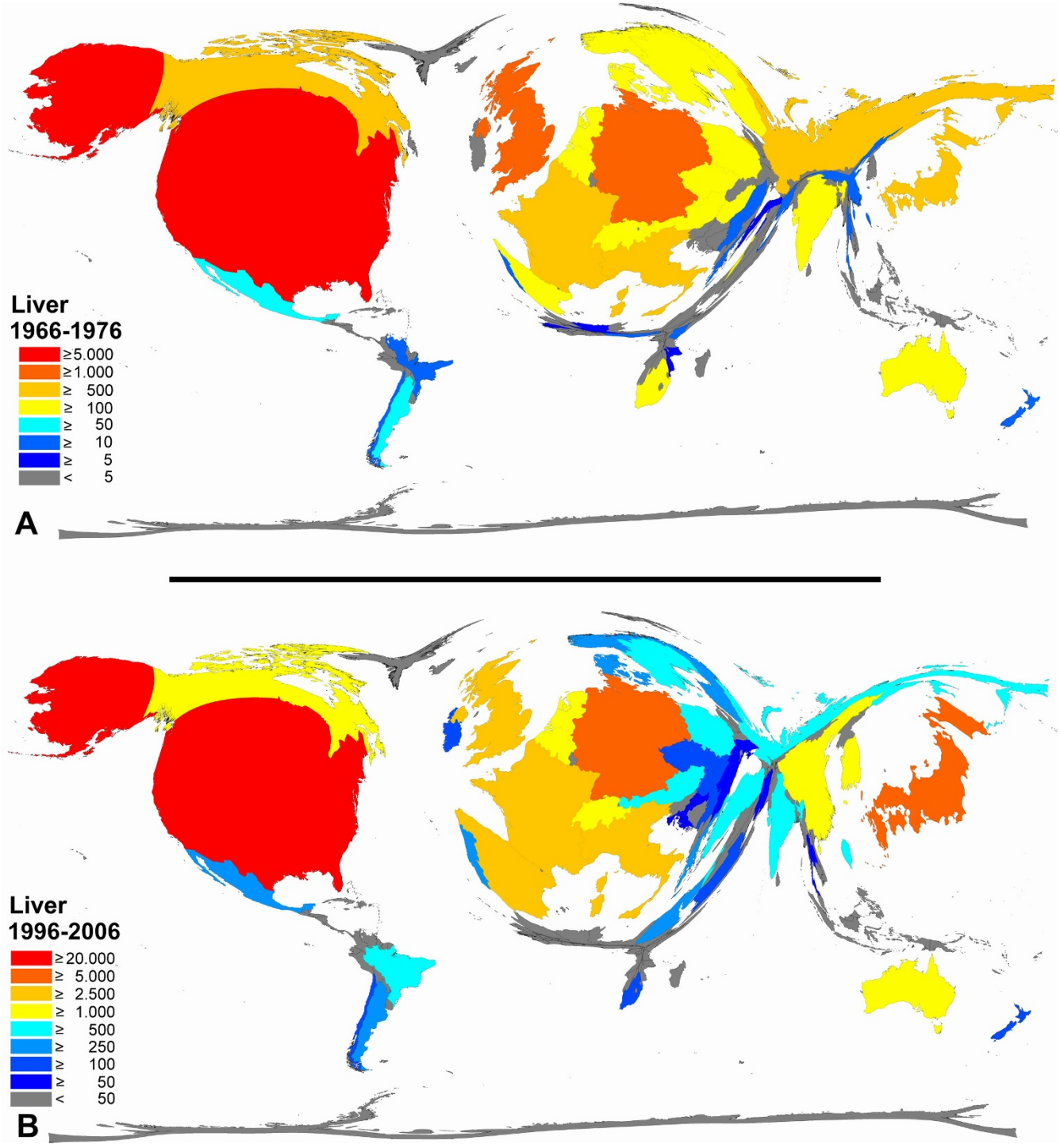

Figure 7
Color-coded Density-equalizing mapping: Publication quantities for items related to the term "liver" in the two periods 1966–1976 and 1996–2006. Web of Science data base search.

The density equalizing cartogram of the liver which is an organ of primary interest of many Asian countries demonstrates a relative increase for China and a decrease for Russia between 1966–1976 and 1996–2006 (Figure 7). Also, a relative increase of the proportion of Spain is present while South Africa's proportion decreased.

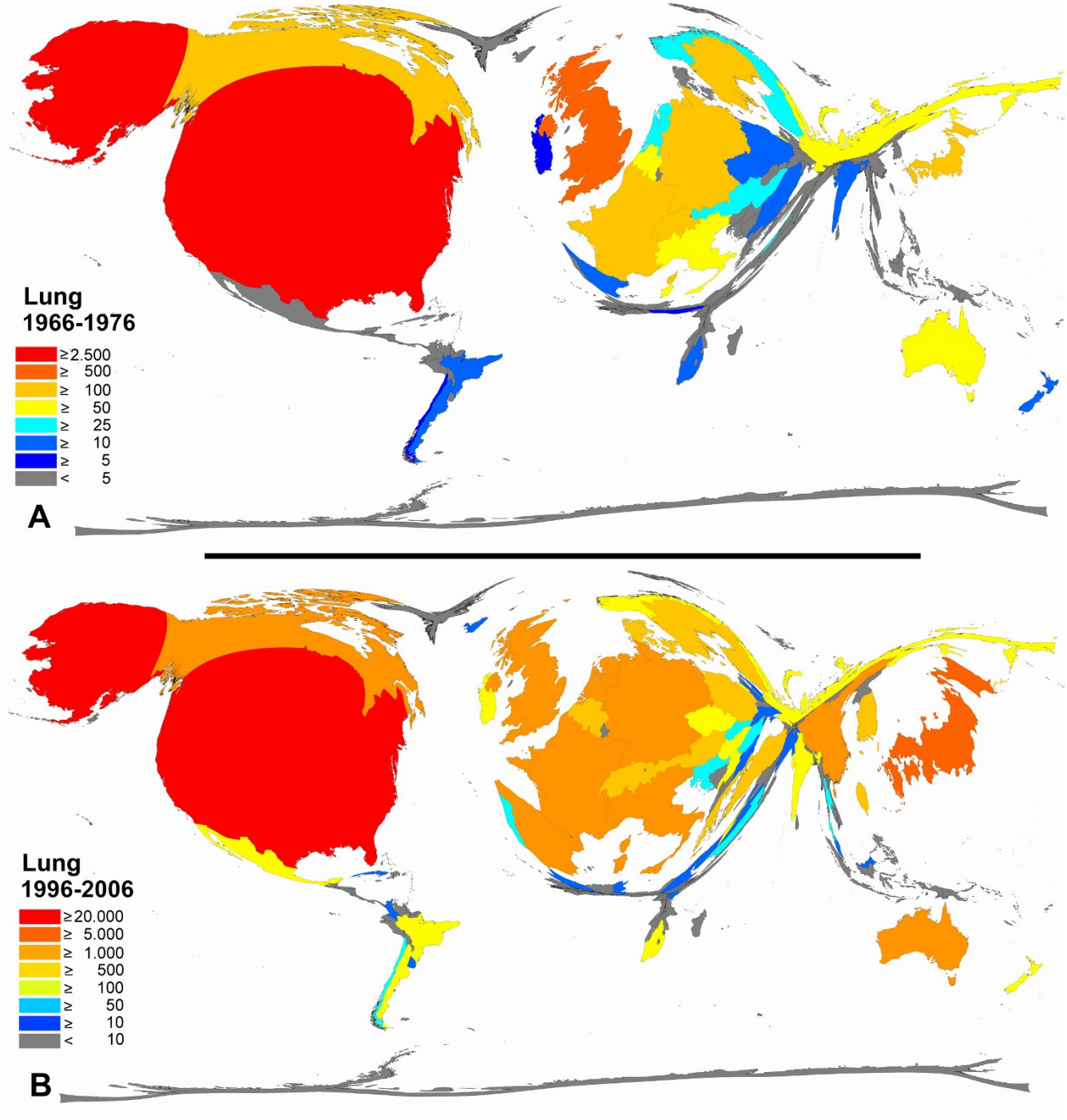

Figure 8
Color-coded Density-equalizing mapping: Publication quantities for items related to the term "lung" in the two periods 1966–1976 and 1996–2006. Web of Science data base search.

For articles related to the lung (Figure 8) and to the skin (Figure 9), a clear proportional increase between the periods of 1966–1976 and 1996–2006 is present for Japan, Spain and China while Russia (lung and skin) and South Africa (skin) slightly decrease in their proportion.

Discussion

The present study was conducted to provide novel data on global scientific publication activities as a benchmark of research output. In this respect a focus was set primarily on the quantity over the past 50 years – not on the quality

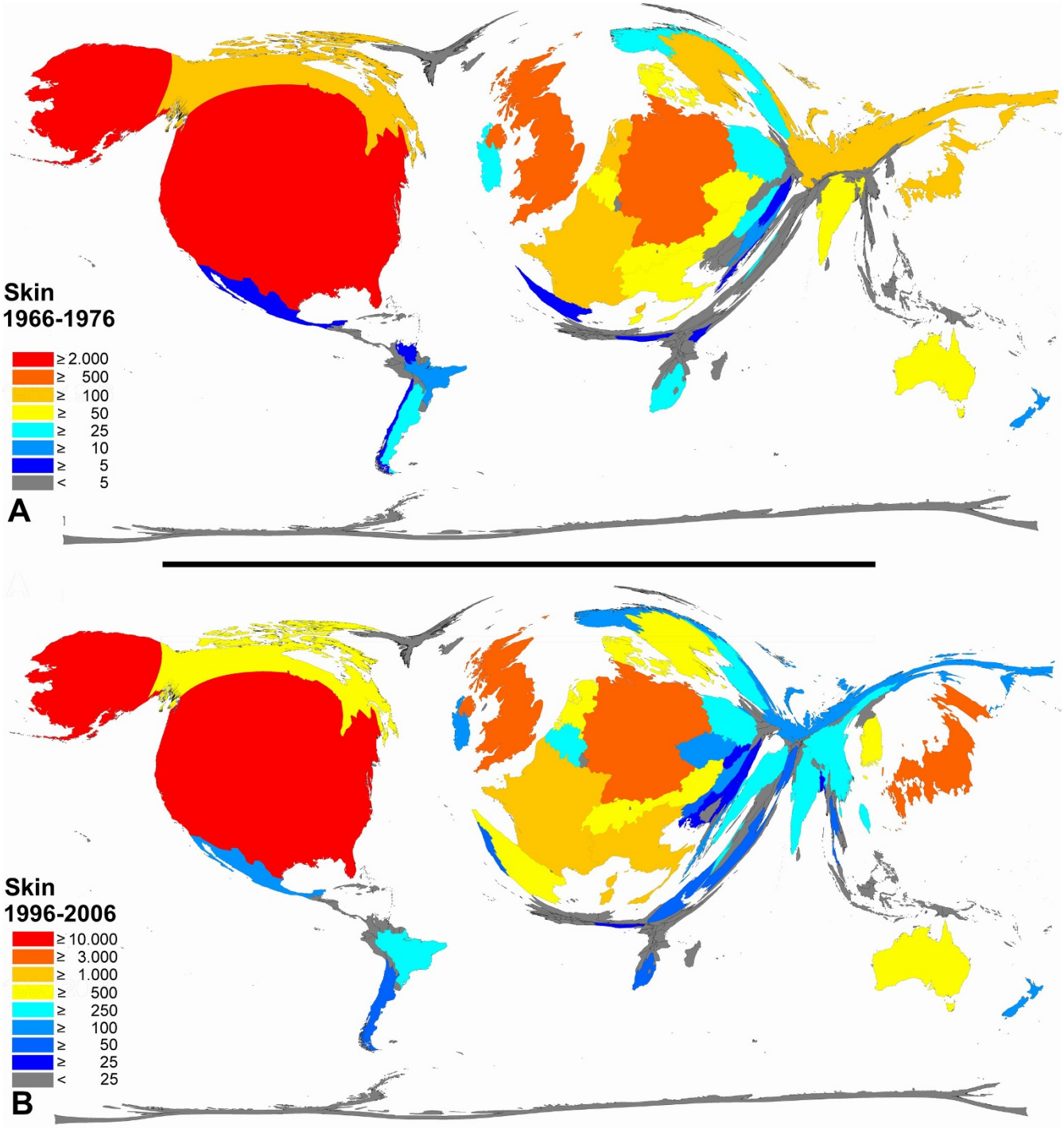

Figure 9
Color-coded Density-equalizing mapping: Publication quantities for items related to the term "skin" in the two periods 1966–1976 and 1996–2006. Web of Science data base search.

which is subject to further studies. Research in this area is of major importance since the policy settings for biomedical and medical research evaluation urgently need review. In the past, numerous scientific reviews and original publications have identified the primacy of quantity over quality as one of the most important threads. Research evaluation and policy projects in countries such as the USA or Australia have described the existence and nature

of this problem extensively in their countries but there is still a lack concerning global data. Also, for Europe only little data is available [10,42,43].

The methodological basis of the study consists of database searches using the Scopus and Web of Science databases and the three characteristics 1) organs – to relate the data to clinical and biomedical fields, 2) countries – to provide a global overview of output activity and 3) publication dates – to assess changes over the time.

The range of analyzed scientific publications is unique. However, it should be realized that every database research houses limitations. In the present case, the definition of organ-related terms displays a major limitation since the list of organs (brain, heart, artery, vein, lung, muscle, eye, nose, ear, throat, neck, skin, breast, stomach, intestine, pancreas, kidney, genital, hormone, arm, and feet) can not be representative. Important aspects of diseases, symptoms, syndromes and clinical fields were not included in order to be able to delineate the enormous amount of data files. In this respect, it can be stated that i.e. published items related to blood disorders are not recognized through the search routines.

Also, the issue of linguistic differences and its effects on publication quantity should be addressed. In this respect, the present study included the analysis of publications in all languages included in the data bases. The majority of publications is published in English and it is difficult for non-English journals to get included in the data bases. Therefore, numerous scientific publications in languages other than English are not accessible by the present approach. This is a major bias. Therefore, English speaking countries such as the US, Canada or the UK have an advantage. However, it is generally accepted that scientists from non-English speaking countries in Europe and Asia publish their high quality research in scientific journals that use English as language.

Numerous interesting aspects are found in the present study. In this respect, the first analysis of total numbers of published items reveals a ranking of US, Japan, Germany, UK and France. This ranking parallels the results of many other research benchmarking systems with the US as the top-ranked country [44,45]. However, when the total number of published items is related to the GDP, the 3.3 fold differences between the top-ranked US (1,893,800 published items) and the second ranked Japan (573,473) completely changes and the US and Japan are listed at position 14 and 17, respectively, while countries such as Israel, Sweden and the Eastern European country Hungary lead the field. Similar changes are seen when the data are related to the number of inhabitants with the US and Japan being listed at position 10 and 15, respectively, with Sweden, Switzerland and Israel at the top 3 positions.

The benchmarking process can be subdivided into several fields. A division into indices for different organs makes sense in order to specify the clinical and research focus of single countries. When each organ is assessed for its relevance within each country, a relatively high homogeneity is present: The US ranks first for every organ followed by Japan, UK and Germany. Also for other countries, a high homogeneity is present (i.e. France is ranked number 5 in 18 out of 22 organ categories). Further separation into 5 separate periods from 1961–1970, 1971–1980, 1981–1990, 1991–2000 and 2001–2007 (online supplement file 1) demonstrates similar tendencies.

When individual country-specific organ research focuses are analyzed, continental differences become evident. Western countries such as the US have a clear ranking with the primary focus on articles related to heart (1), brain (2). Muscle (3), liver (4) and lung (5) this focus is more or less similar in the United Kingdom, Germany or Switzerland with an identical top 3. The reason is a similar research and funding policy with a focus on diseases related to the cardiovascular and the nervous systems as indicated in other studies [46]. These diseases also constitute a major burden of disease [47].

In contrast, Asian countries such as Japan, China, South Korea or India have their primary focus on articles related to the liver. Analyzing the burden of disease in these countries, liver related diseases are not at first position. Interestingly, countries such as Australia that are known to have a critical problem with skin cancer due to sun exposure [48] do not have skin-related publications in a top focus.

A further large analysis (online supplement 2) screened differences in the research output with regard to the five periods 1961–1970, 1971–1980, 1981–1990, 1991–2000 and 2001–2007. This data set illustrates a general increase in quantitative output. In this respect, the period of 2001–2007 can not be fully compared to the previous decades due to a lack of 3 years of research.

The final step of this study encompassed a Web of Science analysis using previously published density equalizing algorithms in order to visualize global trends in quantitative research output. Large increases in overall numbers of published items were present. This is in accordance to commonly known trends [49]. The proportions of leading countries is more or less similar in the two time periods (1966–1976 and 1996–2006) and only minor proportional changes can were found. In this respect, a general increase was present for the countries Spain and China in relation to their neighboring countries.

Summarizing these different data analysis approaches, the current study allows to quantify research output globally with regard to a list of 22 relevant organs and selected time periods. The overall result that the US is the predominant country in every quantitative biomedical research outcome parameter is a generally known fact. These finding points to a valid choose of search terms. However, the present approach also provides a broad spectrum of new information. I.e. the high level of homogeneity that is present in the most productive countries concerning their focus of research with similar organs being listed in the top ten. In this respect, a dichotomy is present: Whereas western countries have a clear focus on heart- and brain-related publications, the Asian countries all primarily focused on publications related to the organ liver. This can not be attributed to the burden of disease which is dominated by cardiovascular, neurovascular, respiratory and infectious diseases [47].

Whereas the present study generated a large set of data it needs to be taken into account that this data only describes the quantitative output. Benchmarking systems should also estimate qualitative aspects. The commonly used marker for research quality is the citation index and future studies need to assess this feature. However, it can be estimated from the present data analysis that citation indices will be high for those organs that also have the highest numbers of published items since a citation can only be traced in a published item and a high number of published items also indicate a high number of citations.

In summary, the present study encompasses a novel approach to assess output in research. It was conducted to provide and interpret quantitative benchmarking data on global publication activities. While the US was the leading country in all relevant categories followed by Japan, an interesting dichotomy was present between Western countries such as the US, UK or Germany and Asian countries such as Japan, China or South Korea concerning their primary research interests. Benchmarking systems basing on research output can be used to identify individual and regional differences. However, they need to be backed up by qualitative benchmarks and socioeconomic data to improve international policy settings for research evaluation.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

BGK conceived of the study, participated in the design and co-ordination of the study, performed the analysis, and drafted and prepared the manuscript, CS, CK and SK participated in the analysis, AF and DQ helped to interpret the data. All authors read and approved the final manuscript.

Additional material

Additional file 1

Number of published items for every organ over 5 time periods. In this file a Scopus – data research was performed for every organ. The research included the periods between 1961–1970, 1971–1980, 1981–1990, 1991–2000, and 2001–2007 (decade 2000–2010 not finalized).
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Additional file 2

Number of published items for every organ over 5 time periods. In this file a Scopus – data research was performed for every organ. The research included the periods between 1961–1970, 1971–1980, 1981–1990, 1991–2000, and 2001–2007 (decade 2000–2010 not finalized).
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References

1. King DA: **UK must go on promoting and funding science.** *Nature* 2005, **438:**24.
2. Dezhina I, Graham LR: **Research funding. Science foundations: a novelty in Russian science.** *Science* 2005, **310:**1772-1773.
3. Dalton R: **California prepares to roll out stem-cell funding.** *Nature* 2005, **437:**800-801.
4. Schirber M: **Biomedical policy. U.K. doubles stem cell funding.** *Science* 2005, **310:**1599.
5. Giles J: **Research grants: the nightmare before funding.** *Nature* 2005, **437:**308-311.
6. Dressler GR: **Proposed changes to biomedical funding.** *Science* 2005, **310:**1279.
7. Jayaraman KS: **Wellcome funding.** *Nature* 2005, **436:**489.
8. Kintisch E: **U.S. economy. Panel calls for more science funding to preserve U.S. prestige.** *Science* 2005, **310:**423.
9. Wadman M: **Disappointment in slow-down for biomedical funding.** *Nature* 2005, **433:**559.
10. Wiley MM: **The Irish health system: developments in strategy, structure, funding and delivery since 1980.** *Health Econ* 2005, **14:**S169-186.
11. Charlton BG, Andras P: **Medical research funding may have over-expanded and be due for collapse.** *Qjm* 2005, **98:**53-55.
12. Birkhahn RH, Van Deusen SK, Okpara OI, Datillo PA, Briggs WM, Gaeta TJ: **Funding and publishing trends of original research by emergency medicine investigators over the past decade.** *Acad Emerg Med* 2006, **13:**95-101.
13. **Time to reform European science funding.** *Nat Neurosci* 2004, **7:**895.
14. Fuster V: **Dilemmas of NIH funding for cardiovascular research.** *Circulation* 1998, **98:**1253-1254.
15. Lewison G, Grant J, Jansen P: **International gastroenterology research: subject areas, impact, and funding.** *Gut* 2001, **49:**295-302.
16. Nossal GJ: **A healthier climate for the funding of vaccine research.** *Nat Immunol* 2004, **5:**457-459.
17. Schiermeier Q: **Berlin places genomics among top funding priorities.** *Nature* 1999, **402:**568.
18. Abbott A: **Germany to shift funding from physics to biology.** *Nature* 1992, **357:**182.

19. Bartels D, Abir-Am P: **The Rockefeller Foundation's funding policy for molecular biology: success or failure?** *Soc Stud Sci* 1984, **14:**238-243.
20. Muller-Hill B: **Funding of molecular biology.** *Nature* 1991, **351:**11-12.
21. Campbell A: **Ethos and economics: examining the rationale underlying stem cell and cloning research policies in the United States, Germany, and Japan.** *Am J Law Med* 2005, **31:**47-86.
22. Stevens D: **Embryonic stem cell research: will President Bush's limitation on federal funding put the United States at a disadvantage? A comparison between U.S. and international law.** *Houst J Int Law* 2003, **25:**623-653.
23. Taylor PL: **The gap between law and ethics in human embryonic stem cell research: overcoming the effect of U.S. federal policy on research advances and public benefit.** *Sci Eng Ethics* 2005, **11:**589-616.
24. Moser G: **["A model of joint research"? Cancer research and the funding policies of the German Research Foundation and the Reich Research Council in National Socialist Germany].** *Medizinhist J* 2005, **40:**113-139.
25. Reed DA, Kern DE, Levine RB, Wright SM: **Costs and funding for published medical education research.** *Jama* 2005, **294:**1052-1057.
26. Darbyshire P, Downes M, Collins C, Dyer S: **Moving from institutional dependence to entrepreneurialism. Creating and funding a collaborative research and practice development position.** *J Clin Nurs* 2005, **14:**926-934.
27. Thies KM, Harper D: **Medicare funding for nursing education: proposal for a coherent policy agenda.** *Nurs Outlook* 2004, **52:**297-303.
28. Crane BB, Dusenberry J: **Power and politics in international funding for reproductive health: the US Global Gag Rule.** *Reprod Health Matters* 2004, **12:**128-137.
29. Zwingmann C, Buschmann-Steinhage R, Gerwinn H, Klosterhuis H: **[The "rehabilitation sciences" research funding programme: research findings – implementation – impact and perspectives].** *Rehabilitation (Stuttg)* 2004, **43:**260-270.
30. DeLisa JA, Rosenthal M: **Funding for rehabilitation medicine: building research capacity.** *Am J Phys Med Rehabil* 2005, **84:**991-998.
31. Anderson A: **Funding in Europe: how the big three cope.** *Science* 1991, **254:**1118.
32. Beauchamp TL: **Ethical issues in funding and monitoring university research.** *Bus Prof Ethics J* 1992, **11:**5-16.
33. Jellinek MS, Levine RJ: **IRBs and pharmaceutical company funding of research.** *Irb* 1982, **4:**9-10.
34. Gronbjerg KA: **How nonprofit human service organizations manage their funding sources: key findings and policy implications.** *Nonprofit Manag Leadersh* 1991, **2:**159-175.
35. Ratcliffe J: **The influence of funding agencies on international health policy, research and programs.** *Mobius* 1985, **5:**93-115.
36. Geisow MJ: **Public funding of research and development: a broad picture.** *Trends Biotechnol* 1991, **9:**76-77.
37. Sevinc A: **Web of science: a unique method of cited reference searching.** *J Natl Med Assoc* 2004, **96:**980-983.
38. Sevinc A: **Multilingual approach to "Web of Science".** *J Natl Med Assoc* 2005, **97:**116-117.
39. **International monetary fund** [http://www.imf.org/]
40. **World factbook** [https://www.cia.gov/library/publications/the-world-factbook/index.html]
41. Gastner MT, Newman ME: **From The Cover: Diffusion-based method for producing density-equalizing maps.** *Proc Natl Acad Sci USA* 2004, **101:**7499-7504.
42. France G: **Centralised versus decentralised funding of evaluative research: impact on medical technology policy in Italy.** *Soc Sci Med* 1994, **38:**1635-1641.
43. Boldt J, Zoch TB: **[Funding of research projects–the importance of foundations].** *Anasthesiol Intensivmed Notfallmed Schmerzther* 2002, **37:**600-603.
44. Soteriades ES, Falagas ME: **Comparison of amount of biomedical research originating from the European Union and the United States.** *Bmj* 2005, **331:**192-194.
45. Fritzsche FR, Oelrich B, Dietel M, Jung K, Kristiansen G: **European and US publications in the 50 highest ranking pathology journals from 2000 to 2006.** *J Clin Pathol* 2007.
46. Siegel JE, Byron SC, Lawrence WF: **Federal sponsorship of cost-effectiveness and related research in health care: 1997–2001.** *Value Health* 2005, **8:**223-236.
47. Lopez AD, Mathers CD, Ezzati M, Jamison DT, Murray CJ: **Global and regional burden of disease and risk factors, 2001: systematic analysis of population health data.** *Lancet* 2006, **367:**1747-1757.
48. Wilkinson D, Askew DA, Dixon A: **Skin cancer clinics in Australia: workload profile and performance indicators from an analysis of billing data.** *Med J Aust* 2006, **184:**162-164.
49. Huang YL, Ho YS, Chuang KY: **Bibliometric analysis of nursing research in Taiwan 1991–2004.** *J Nurs Res* 2006, **14:**75-81.

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