doi: 10.4183/aeb.2015.343

EDITORIAL

TRENDS OF ROMANIAN MEDICAL RESEARCH 1990-2014

A.D. Corlan*

University and Emergency Hospital of Bucharest, Research Department, Bucharest, Romania

ROMANIAN RESEARCH AFTER 1989

In the early nineties, following the fall of communism, the Romanian research system was almost entirely disconnected from the international scientific community. During the previous decades it had been impossible for most academics to travel outside Romania, to obtain any international literature or to publish abroad.

The research system was inbred, and consisted primarily of research institutes, especially in industrial research, and also universities that can largely be described as pre-humboldtian in organisation (1), despite being public bodies. Private research was, of course, almost absent.

Over the next decade, the rather substantial research system, designed mostly to support reverse engineering of western products for assimilation into the local industry, began to disappear under a number of pressures, such as the massive brain drain, funding cuts and the substantial contraction of the non-competitive industries that the research system was relying on.

The system reached a nadir, perhaps, around 2004, considering the trend of GERD (2). The legal definitions of terms like 'research', 'applicative research', 'experimental development' were not fully synchronised with the OECD definition until 2011 (3) and some are still used differently (4), thus comparison of indicators is difficult.

After 2000, a number of encouraging developments began to emerge. Internet connectivity spread very fast in Romania, starting with the academic system. This fact progressively eased access to literature, a problem that had remained acute during the nineties. Then, accession to NATO and the EU became the primary aims of national policies. EU accession was accompanied by a formal, national commitment to modernise and enhance the research system, and also to increased public investment in research. The currently declared target, for 2020, is to achieve 1% of GDP from public and 1% from private funds (5, 6).

Investment in research increased year by year until 2009 when, following the economic crisis, cuts were introduced. Over the next years, public funding fluctuated, currently being back at 2004 levels (2). Recovery of funding levels is not, in fact, anticipated over the next years (7).

BIOMEDICAL RESEARCH

Research (clinical) hospitals and medical universities were not much affected by the reduction of scientific research in the industrial institutes in the nineties. Still, the above trend—a reduction of research activity after 1990, followed by recovery after 2000 - can be seen in the number of PubMed entries for papers published in journals having the publisher in Romania, year by year (Fig. 1), although this effect is probably also due to some PubMed indexing decisions.

Until about 2005, at least, the situation of the local research journals, across the scientific disciplines, was poor (8) though enough medical journals survived to allow the computation of a local impact factor (9). Later, numerous local journals of varying quality appeared (10). This may have been due, speculatively, to the anticipation of a switch to international criteria and metrics for funding and promotion, an increased awareness of such issues, a reduction in publication costs and increased funding, among other causes.

The identification of the country where authors are affiliated is unreliable in PubMed before 2008. In particular, "Romania" probably only, or mostly, appeared in author addresses for papers published abroad before that date. In Figure 1, papers are assigned to countries using the 'AD' Medline field, that is typically the affiliation of the first author. For a more detailed discussion of these technicalities, see reference (11). Anyway, as can be seen in Figure 1, the number of papers where authors indicate "Romania" for their address shows a sustained increase over

*Correspondence to: Alexandru Dan Corlan MD, University and Emergency Hospital of Bucharest, Research Department, 169 Spl. Independentei, Bucharest, 050098, Romania, E-mail: alexandru@corlan.net

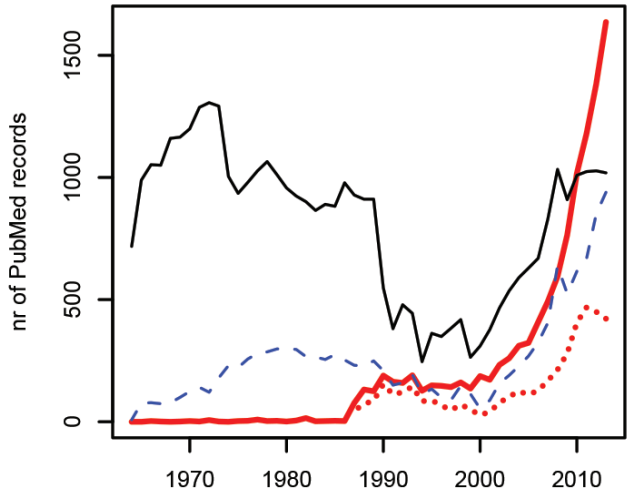

Figure 1. Number of yearly PubMed entries where the place of publication is Romania (full black, query: Romania[pl]); the number of such entries in English (dashed blue, query Romania[pl] and eng[la]); the number of papers published with an address from Romania (full red, query: Romania[ad]) and the number of papers with an address from Romania in a journal from Romania (dotted red, query: Romania[ad] and Romania[pl].

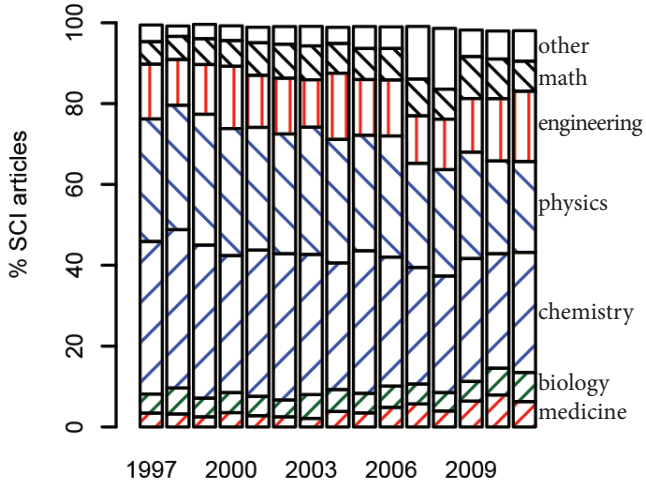

Figure 3. Yearly evolution of the domain composition of article output from Romania, as found in SCI.

the last 15 years. The number of papers in PubMed-indexed Romanian journals show a sharp increase after 2000, then levels off after 2007. Most of these journals are now published in English (the dashed, blue line), unlike before 1990. Authors from Romania seem to become progressively less interested in the local journals after 2010 (the dotted red line in Fig. 1), while quickly increasing their output in foreign journals (the difference between the full and the dotted red lines).

Local journals appear to increasingly rely on international authors (the difference between dotted red and full black line in Fig. 1). Between 2008 and 2012,

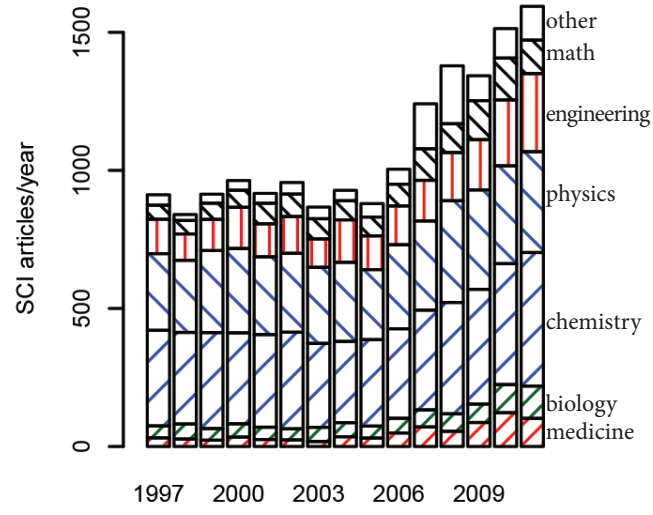

Figure 2. Yearly evolution of the number of articles with Romanian affiliation of their authors found in Science Citation Index (SCI), by domain.

2813 papers were published in Romanian journals that are indexed by PubMed (Table 1). Of these, 1817 (64.6%) originated from Romania (had 'Romania' in the author's address) and 996 (35.4%) from other countries, mostly from the USA, Greece, Iran, Turkey, India, Italy, Germany, Spain and the UK. About 57% of papers from Romania were published abroad.

In PubMed, there are 1.132.991 entries for 7.2 billion people in 2013, that is over 157 entries per million people. For Romania, there were 1636 entries for a population of about 19 million, thus 86.1 per million, that is less than 55% of the world average.

In summary, based on PubMed, the presence of Romanian published journals, as well as Romanian authored papers was much reduced between 1990 and 2000 at less than half the levels before 1990. After year 2000, a fast increase in both local journals and locally authored papers occurred. Progressively, internationalisation of both journals and publishing practices took place: local journals rely more and more on international input, and Romanian authors publish increasingly abroad. However, the presence of Romanian publications in PubMed, per capita, only reached about half the global average.

PubMed does not only contain research articles, but many professional essays as well. Also, it does not cover only biology and medicine, but also some chemistry, physics, engineering and other journals, sometimes only vaguely related to medicine.

Another useful source of data is the biennial report "Science and Engineering Indicators" produced by the National Science Board of the USA, the latest

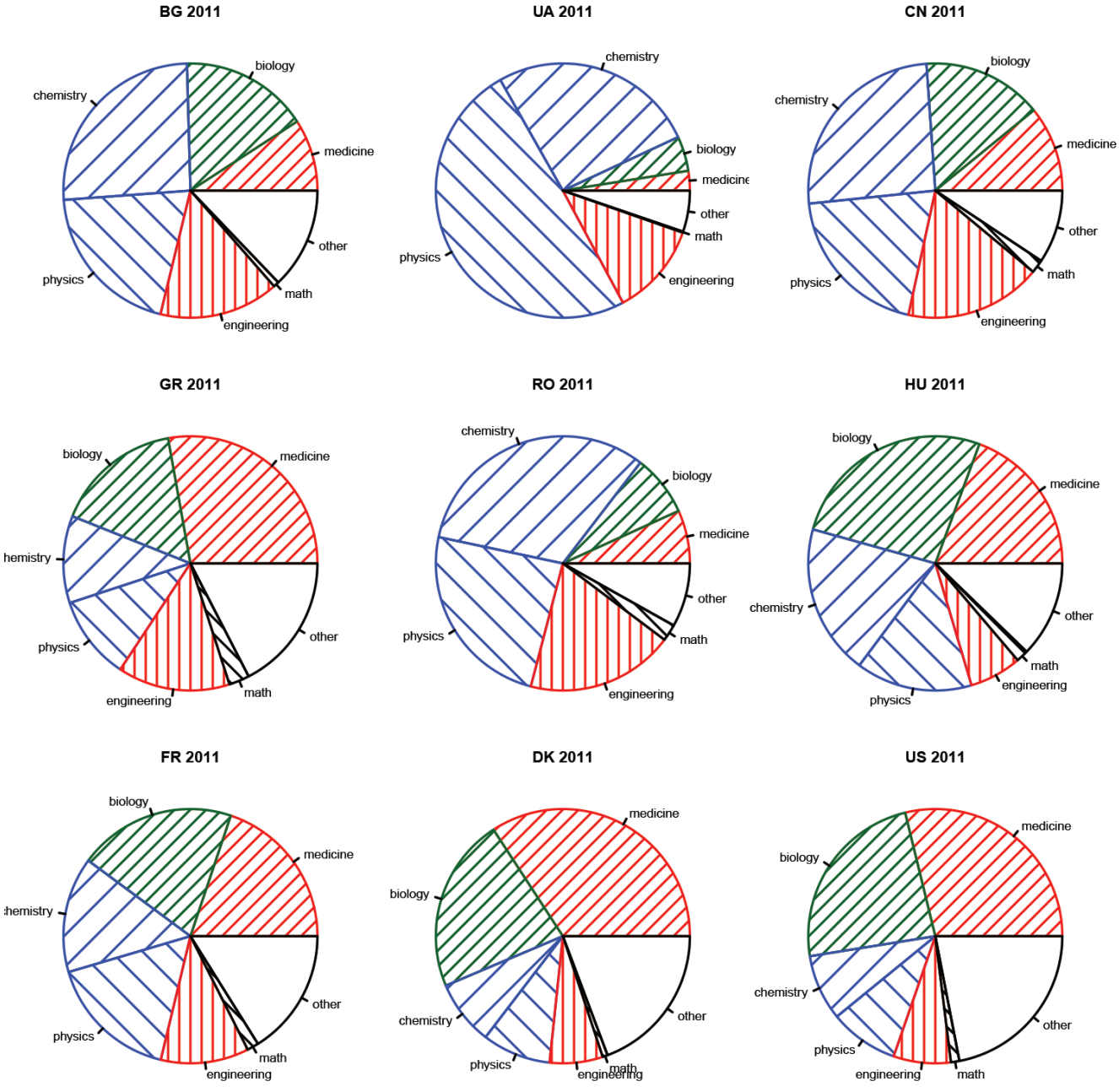

Figure 4. Country comparison of domain composition of article output in SCI, 2011.

edition being from 2014 (12). Academic output is evaluated in this report using only the Science Citation Index (SCI), by assigning to a country, for each paper, the fraction of authors that have an affiliation in that country. Detailed tables, with classification by country and broad domain, are available as appendices. We constructed Figures 2-4 from these tables (appendices 5-26 to 5-39).

The sustained, recent, increase observed in PubMed records originating from Romania is also present in the SCI database, however it starts in 2006 rather than 2000. The relative prevalence of biomedical literature increased slightly, but the general structure of the research system remains focused on chemistry, physics and mathematics.

In all fields, 85.6 SCI articles per million inhabitants (apm) were published from Romania in 2011, compared to the world average of 114.9 apm; in medicine, 5.36 apm for Romania, *vs.* 25.4 apm worldwide; in biology, 6.17 apm *vs.* 22.5 apm worldwide. Medicine and biology papers represented 7.2% and 6.7% of all papers published from Romania in 2011, compared to 22.1% and 19.5% worldwide. Figure 4 shows the research system structure of a few countries, based on the broad domain of each paper published in 2011.

Table 1. PubMed indexed articles by country, 2008–2012: 1. total articles from that country in PubMed; 2. article from that country appearing in journals published in Romania; 3. % of (2) from all articles in journals published in Romania; 4; % of (2) from (1). Countries with a single paper were not included.

Author affiliation	1 Total	2 In Rom journal	3 % from Rom j	4 % from total
Romania	4241	1817	64.593	42.844
Moldova	70	17	0.604	24.286
Azerbaijan	118	5	0.178	4.237
Montenegro	102	1	0.036	0.980
Latvia	394	2	0.071	0.508
Serbia	5081	21	0.747	0.413
Greece	24204	79	2.808	0.326
Bulgaria	2016	6	0.213	0.298
Iran	25705	68	2.417	0.265
Hungary	8994	13	0.462	0.145
Turkey	46726	52	1.849	0.111
Malaysia	8372	9	0.320	0.108
India	90133	81	2.879	0.090
Saudi Arabia	6572	5	0.178	0.076
Ireland	16676	12	0.427	0.072
Norway	19774	12	0.427	0.061
Colombia	3325	2	0.071	0.060
Austria	21185	12	0.427	0.057
Italy	127900	63	2.240	0.049
Germany	175145	78	2.773	0.045
Spain	85700	36	1.280	0.042
Portugal	16676	7	0.249	0.042
Egypt	9583	4	0.142	0.042
Poland	26207	10	0.355	0.038
South Africa	10866	4	0.142	0.037
Nigeria	6158	2	0.071	0.032
Singapore	15734	5	0.178	0.032
United Kingdom	266503	77	2.737	0.029
Israel	33094	8	0.284	0.024
Belgium	33283	8	0.284	0.024
Brazil	62945	14	0.498	0.022
Finland	19949	4	0.142	0.020
Netherlands	77662	15	0.533	0.019
Russia	11298	2	0.071	0.018
Czech Republic	12610	2	0.071	0.016
Argentina	13309	2	0.071	0.015
Canada	122470	18	0.640	0.015
Switzerland	41886	6	0.213	0.014
France	121337	17	0.604	0.014
Sweden	43839	6	0.213	0.014
Japan	201684	25	0.889	0.012
USA	970870	117	4.159	0.012
Korea	88529	10	0.355	0.011
Denmark	28890	3	0.107	0.010
Australia	90606	9	0.320	0.010
China	292897	29	1.031	0.010
Taiwan	48193	4	0.142	0.008

DISCUSSION

Counting papers is a widely used method for gross assessment of some features of larger research systems, such as national systems (13). While such bibliometric indicators can also be misused in various ways (14), they are predictive of other important features of the system they characterise, such as GDP growth rate in emerging countries (15) or the quality of the health services of a hospital (16).

The Romanian research system stagnated during the nineties, corresponding to massive transformations of the autarchic research system that was inherited from the eighties. The reconnection with the international scientific community gathered pace after year 2000, a phenomenon that is reflected in a sustained increase in the visibility of Romanian academic research, although not also of industrial research (12, annex 6-54), as well as in the globalisation of both the publishing practices of Romanian authors and of the authorship attracted by journals located in Romania.

The increase in article output is more sustained in PubMed and less so in Science Citation Index, that includes only research papers.

The structure of the research system, inherited from the communist regime, was heavily focused on physical sciences and engineering, rather than biomedical sciences. In contrast, in European Union countries and the USA, most of the research output is in biomedical and socio-economical sciences (12, Chapter 5). In Romania, the output from biomedical sciences grew more than from the other fields in the last decade, but only slightly, and the overall structure of the Romanian research system remains essentially unchanged.

Despite these encouraging trends, article output per capita from Romania is still very low, especially in biomedical fields, where it is between 1/4 of the world average for research (SCI) papers and 1/2 for all PubMed indexed papers.

Full reintegration into the world scientific system, as well as modernisation of the structure of the research system, would be certified, in the future, by sustained increased research output, especially in medicine and biology. This is also a mandatory prerequisite for sustained economic development (15). Increased financial investment in research, particularly biomedical, is a necessary condition, although it would not be sufficient in itself. Unfortunately, increased investment seems unlikely given recent trends (2, 7).

Conflict of interest

The author declares that he has no conflict of interest concerning this article.

References

1. Clark W. Academic Charisma and the Origins of the Research University. University of Chicago Press; 2007.
2. Corlan AD, David D, Frangopol P, Trache L. Raportul Grupului de Analiză, Atitudine şi Acţiune în Politica Ştiinţei din România pentru anul 2014. [G3A think tank report for 2014]. Revista de Politica Stiinţei şi Scientometrie, Serie Noua. 2014;3(4):255–277. Available from: http://rpss.inoe.ro/articles/182.
3. Ordonanţa nr 57/2002 privind cercetarea ştiinţifică şi dezvoltarea tehnologică cu modificările ulterioare; 2002. [Research law of Romania]. Available from: http://www.ancs.ro/uploads/legislatie/og-57.doc.
4. ***. Anuarul Statistic al României. [Yearly statistical overview of Romania]. Institutul Naţional de Statistică; 2012.
5. HG 929/2014, Strategia naţională de cercetare, dezvoltare şi inovare a României, 2014–2020. MO 785; 2014. [Government decision 929/2014. The national research, development and innovation strategy for Romania, 2014–2020]. Available from: http://www.research.ro/uploads/sistemul-de-cercetare/strategie-mo-1.doc.
6. Obiective pentru Strategia Europa 2020; 2013. [Targets of the Europa 2020 strategy for Romania]. Available from: http://ec.europa.eu/europe2020/pdf/targets_ro.pdf.
7. Legea 186/2014, Legea bugetului de stat pe anul 2015. MO 930; 2014. [Romanian State Budget Law for 2015].
8. Florian R, Florian N. Majoritatea revistelor ştiinţifice româneşti nu servesc ştiinţa. [Most Romanian research journals do not serve science.] Ad Astra journal. 2006;5. Available from: www.ad-astra.ro/journal/9/florian_reviste_locale.pdf.
9. Robu I, Marineanu D, Aciu I, Wood-Lamont S. Improving standards in the scientific biomedical community in Romania by using journal ran king to improve journal quality. Health Information and Libraries Journal. 2001;18:91–98. Available from: http://www.ad-astra.ro/library/papers/Robu_Biomedical_journals.pdf.
10. Ohler F, Ioniţă M, Ţoncu AC. Romania's Research, Development and Innovation policy: Another view on European integration. Revista de Politica Stiinţei şi Scientometrie—Serie Nouă. 2012;1(1):3–14. Available from: http://rpss.inoe.ro/articles/2.
11. Corlan AD. Explorarea tendinţelor temporo-spaţiale ale cheilor de căutare pentru cercetarea biomedicală folosind baza de date Medline/PubMed. [Exploring the temporo-spatial trends of keyword occurrence using the Medline/Pubmed database] Revista de Politica Ştiinţei şi Scientometrie (serie noua). 2012;1:281–292.
12. ***. Science and Engineering Indicators. National Science Foundation. National Center for Science and Engineering Statistics; 2014.
13. Okubo Y. Bibliometric Indicators and Analysis of Research Systems: Methods and Examples. OECD Science, Technology and Industry Working Papers. OECD Publishing; 1997. Available from: http://dx.doi.org/10.1787/208277770603.
14. Wallin J. Bibliometric methods: pitfalls and possibilities. Basic Clin Pharmacol Toxicol. 2005;97:261–75.
15. Lee LC, Lin PH, Chuang YW, Lee YY. Research output and economic productivity: a Granger causality test. Scientometrics. 2011;89:465–478.
16. Corlan AD. Relaţia între o evaluare bibliometrică şi clasificarea spitalelor din România după performanţa profesională. [The relashionship between a bibliometric evaluation and the professional classification of Romanian hospitals]. Revista de Politica Ştiinţei şi Scientometrie–serie nouă. 2012;1(2):116.