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Opportunities to Increase the Efficiency of Universities' Research and Innovation Activities: Scientometric Evaluation of Researchers' Work under External Information Constraints

Elvir Akhmetshin [1*], Sergey Makushkin [2], Ilyos Abdullayev [3], Alexey Yumashev [4], Artemiy Kozachek [5], Rustem Shichiyakh [6] and Denis Shakhov [7]

[1] Department of Economics and Management, Elabuga Institute of Kazan Federal University, Elabuga, 423604, Russia;
[2] Department of Complex of Humanitarian Disciplines (Subject-Subject Relations), Russian State Social University, Moscow, 129226, Russia;
[3] Department of Management and Marketing, Urgench State University, Urgench, 220100, Uzbekistan;
[4] Department of Prosthetic Dentistry, Sechenov First Moscow State Medical University, Moscow, 119991, Russia;
[5] Department of Nature Management and Environmental Protection, Tambov State Technical University, Tambov, 392000, Russia;
[6] Department of Management, Kuban State Agrarian University named after I.T. Trubilin, Krasnodar, 350044, Russia;
[7] Department of Economics and Management, Khorezm University, Urgench, 220100, Uzbekistan.

Corresponding author: e-mail: elvir@mail.ru.

ABSTRACT: The development of research and innovation should be a strategic direction of state policy in the sphere of education. This imposes additional functions connected not only with fundamental and applied research, which is the traditional type of research work of universities, but also with the inclusion of universities' research activities into the unified innovation process of the creation and practical application of new knowledge to obtain new goods or services with new properties. The aim of the article is to determine the ability of international scientometric databases to assess the research and innovation activity of Russian universities. The key research method is regression analysis used to establish the relationship between the Hirsch index values for research papers in the Scopus and Google Scholar databases. The paper shows the possibility and expediency of using Google Scholar to evaluate the results of research and innovation activities of medical universities' faculty. This allows increasing the efficiency of the scientometric evaluation of researchers under external information constraints. This corresponds well to the principles of functioning of an entrepreneurial university. The advantage of Google Scholar is the consideration of Russian-language publications in the indexing.

Keywords: International Cooperation; Research and Innovation Activities; Hirsch Index; Scientometric Database; Google Scholar; Scopus.

I. INTRODUCTION

The contemporary university is a multifunctional platform, one of the functions of which is the search for and development of new scientific ideas that contribute to the socio-economic development of the state [1,2]. The innovativeness of science is understood not only as its focus on obtaining new knowledge and discovering new properties of the studied objects but also as the contribution of science to the development of the economic potential of society [3,4]. The main mechanism for this purpose is an effective technology for the transmission of scientific results the process of transferring a new idea, technology, or development to the actors and executors at the subsequent stages of the unified innovation process [5,6]. The research and innovation activity of universities now not only forms the image of an institution but also creates the basis for the state to reach the world level in all spheres of life [7-9].

The current situation calls for a balanced approach to borrowing the existing practices of organizing [10], stimulating, and evaluating research and innovation activities in Russian universities [11], including medical, technical, and socio-humanitarian ones [12]. The state authorities tasked with stimulating the innovative development of the economy [13] along with university management are seeking to determine specific indicators for assessing the results of research and innovation activities, including those of university researchers, which could be set as reference points for its stimulation.

In recent years, the practice of assessing the activities of university faculty members (both in terms of assessing publications for the defense of dissertations, compliance with contract terms, and in selecting grant applications for research projects) based on the citation index of their publications in journals indexed in the international scientific databases Web of Science (WoS) and Scopus (Sc) has become increasingly popular [14].

II. LITERATURE REVIEW

On the one hand, a solution to the problem of evaluating scientific results is to use the entrepreneurial university model, which differs from the Humboldt-type university (which emphasizes teaching and research) based on the following features: a leadership and performance-oriented management style, effective incentives for employees, entrepreneurial approaches in science and education [15], the presence of an entrepreneurial culture [16], partnerships with all stakeholders [17,18]. The most successful universities of this type are usually co-founders of innovative enterprises, the task of which is to commercialize the scientific developments of university staff [19]. The implementation of the concept of entrepreneurial university, also known as academic capitalism, has led these universities to take the first positions in various rankings [20].

On the other hand, in 2022, Sc and WoS announced that they will close access to Russian scientific organizations once their contracts expire. Due to this fact, universities cannot legally conclude contracts and enjoy full access to the databases. O.V. Abramova and I.E. Korotaeva [3] understand the research and innovation activity of a university as a process that assumes the employment of new knowledge, technologies, and methods to support all directions of s university's operation, above all the educational, organizational, managerial, research, and methodological activities.

Analysis of recent publications testifies to the increased attention of the scientific community to the issues of evaluating research and innovation work. A special place within this study is occupied by a thorough analysis of the formalized aspect of bibliometric analysis [21], as well as a comparison of the capabilities of various scientometric databases that they offer for assessing research activity [22]. I.N. Kim [23] analyzes Russian and international experience in using online services that allow for independent international assessment of electronic publications and researchers' publication activity through the analysis of scientometric indicators in open electronic bibliometric systems.

In the last few years, scientists from various countries have conducted comparative studies on the scientometric potential of Google Scholar (GS), WoS, and Sc [24-26]. In a simultaneous comparison, various scientific fields, including medical fields such as oncology and psychiatry, were analyzed in all three scientometric databases [27]. The general conclusion is that GS indexes more publications than the other two databases, and the indexing results of the latter are similar.

Despite the considerable number of research publications on this issue, further reflection is required on the problems of determining the possibilities of objective assessment of the level of research and innovation activity and the choice of scientometric databases, considering the specifics of the scientific and educational institution status in the context of the development of entrepreneurial type universities.

The study aims to fill the gap in understanding the correlation between citation metrics in different databases, especially with a focus on Scopus and Google Scholar, in the context of medical research in Russian universities. It addresses the need for benchmarking research impact measurement tools, which is critical to assessing the visibility and impact of academic work in medicine. By examining this relationship, the study contributes to the broader debate about the effectiveness and reliability of various bibliometric indicators for capturing the true impact of scientific research.

The purpose of this article is to compare the capabilities of scientometric databases for assessing the research and innovation activities of Russian universities.

III. METHODS

1. RESEARCH DESIGN

To achieve the set research goal, the study explored opportunities for using publicly available GS to evaluate research and innovation activities in medical universities, because authors from medical universities are among the most active and publish numerous articles in specialized foreign journals.

The study was conducted in 2022 in cooperation with the Sechenov First Moscow State Medical University, Russian State Social University, Kazan Federal University, Pacific National University, and Moscow Aviation Institute.

The study employed the method of regression analysis to establish the relationship between the values of the Hirsch index (h-index) for papers written by scientists at leading Russian medical universities and indexed in Sc and GS.

The research hypothesis put forward is that for researchers in medical science working in specialized medical universities, citation indicators in GS have a strong correlation with the citation indicators in Sc, so the assessment of scientific and innovative activity in Russian medical universities can be carried out using any one of these scientometric databases.

2. DATA COLLECTION

The theoretical base of the study consists of documents of international organizations on the evaluation of research and innovation, along with scholarly publications on the establishment of an entrepreneurial model of a university and the potential of existing scientometric databases to assess the research and innovation activities of scientific and pedagogical staff.

To test the hypothesis, we selected the works of scientists working in the top 10 Russian specialized medical universities according to the RAEX-Analytics rating group for 2022 (Table 1) [28].

Table 1. Top 10 medical universities in Russia.

Educational institution	Rating (subject: medicine)	RAEX-100 rating	Moscow International Rating "Three Missions of the University"
Sechenov First Moscow State Medical University	1	17	14
Pirogov Russian National Research Medical University	2	22	18-22
Pavlov First Saint Petersburg State Medical University	5	27	18-22
Mechnikov North-Western State Medical University	6	73	43-47
Yevdokimov Moscow State University of Medicine and Dentistry	7	39	43-47
Bashkir State Medical University	8	98	36-42
Siberian State Medical University	10	59	36-42
Privolzhskiy Research Medical University	11	86	28-35
Kazan State Medical University	12	46	63-71
Volgograd State Medical University	14	-	43-47
Rostov State Medical University	15	-	54-62

3. DATA ANALYSIS

Statistical processing was performed on the data of the RSCI (Russian Scientific Citation Index), which contains the values of the h-index in GS and Sc (as of the end of December 2022) in two research areas (clinical and biological research).

As an econometric model, regression analysis is used to establish the relationship between the h-index values for each of the medical universities in GS (H_{GS}) and Sc (H_{Sc}):

$$H_{Sc} = a*H_{GS} + b \quad (1)$$

where H_{Sc} – h-index value for Sc; H_{GS} – h-index value for GS; a and b – regression coefficients.

The regression coefficients were calculated using MS Excel.

IV. RESULTS

The results of the analysis confirm a strong correlation between the h-indexes for the works of researchers from the considered universities in all research areas (Table 2, 3).

Table 2. Parameters of the regression equation for the 10 top Russian medical universities (clinical research).

Educational institution	Statistical characteristics of correlation				H_{Sc} with H_{GS} =		
	a	b	Significance for a	R^2	5	10	15
1. Sechenov First Moscow State Medical University	0.818	-1.945	0.000	0.763	2.2	6.1	10.2
2. Pirogov Russian National Research Medical University	0.767	-1.564	0.000	0.792	2.4	6.2	10.1
3. Pavlov First Saint Petersburg State Medical University	0.655	-1.454	0.000	0.737	1.7	5.2	8.5
4. Mechnikov North-Western State Medical University	0.834	-2.501	0.000	0.861	1.6	5.8	10.0
5. Yevdokimov Moscow State University of Medicine and Dentistry	0.926	-1.754	0.000	0.805	2.9	7.6	12.0
6. Bashkir State Medical University	0.822	-1.583	0.000	0.865	2.4	6.6	10.9
7. Siberian State Medical University	0.484	-1.631	0.000	0.486	0.9	3.3	5.7
8. Privolzhskiy Research Medical University	0.911	-1.471	0.000	0.922	3.0	7.5	12.1
9. Kazan State Medical University	0.818	-2.463	0.000	0.874	1.7	5.8	9.8
10. Volgograd State Medical University	0.852	-1.957	0.000	0.889	2.3	6.5	10.8
Total					**2.6**	**7.0**	**11.5**

The results suggest that for scientists in all the considered medical universities, there is a strong correlation between the citations of their clinical research in Sc and GS.

The results of the regression analysis show that, for the 10 Russian medical universities, the average value of the h-index in Sc in terms of clinical research is lower than that in GS, approximately: a) the h-index of 2.5 = 5 in GS; b) the h-index of 3 = 10 in GS; c) the h-index of 3.5 = 15 in GS.

Table 3. Parameters of the regression equation for the top 10 Russian medical universities (biological research).

Educational institution	Statistical characteristics of the correlation				H_{Sc} with H_{GS} =		
	a	b	Value for a	R^2	5	10	15
1. I.M. Sechenov First Moscow State Medical University	0.822	-1.575	0.000	0.778	2.5	6.6	10.8
2. N.I. Pirogov Russian National Research Medical University	0.797	-1.411	0.000	0.796	2.6	6.6	10.1
3. I.P. Pavlov First Saint Petersburg State Medical University	0.822	-2.075	0.000	0.778	2.0	6.1	10.3
4. I.I. Mechnikov North-Western State Medical University	0.733	-1.571	0.000	0.812	2.1	5.8	9.4
5. A.I. Yevdokimov Moscow State University of Medicine and Dentistry	0.821	-1.353	0.000	0.829	2.8	6.9	11.0
6. Bashkir State Medical University	0.752	-1.877	0.000	0.781	1.9	5.6	9.4
7. Siberian State Medical University	0.911	-1.644	0.000	0.815	2.9	7.5	12.0
8. Privolzhsky Research Medical University	0.833	-1.613	0.000	0.765	2.6	6.7	10.9
9. Kazan State Medical University	0.589	-1.522	0.000	0.576	1.4	4.4	7.3
10. Volgograd State Medical University	0.622	-1.367	0.000	0.821	1.7	4.9	8.0
All universities					**2.8**	**7.1**	**11.4**

Thus, for scientists at all medical universities, there is also a fairly strong correlation between the citation of their biological research in Scopus and Google Scholar.

The results of the regression analysis show that for 10 Russian medical universities, the average value of the H-index in Scopus for biological research is also lower than its average value in Google Scholar approximately: a) by 2 for the level of the H-index in Google Scholar = 5; b) by 3 for the level of the H-index in Google Scholar =10; c) by 3.5 for the H-index level in Google Scholar =15.

Based on the results of regression analysis, we can conclude that for scientists at all medical universities, there is a fairly strong correlation between the citation of their works in Scopus and Google Scholar, regardless of the research field.

The results of the study show that the H-index in the database with a paid subscription (Scopus) is lower than the H-index in the publicly available scientometric database. Thus, we conducted an additional study of the relationship between the values of the H-indices in the public scientometric databases Google Scholar (H_{GS}) and the Russian eLibrary.Ru (H_{eL}) using the same methodology for the entire set of studies (clinical, biological) (Table 4).

Table 4. Regression equation parameters for the top 10 Russian medical universities (clinical, biological research)

Educational institution	Statistical characteristics of the correlation				H_{GS} with H_{eL} =		
	a	b	Value for a	R^2	5	10	15
1. I.M. Sechenov First Moscow State Medical University	0.715	-1.942	0.000	0.755	1.6	5.2	8.8
2. N.I. Pirogov Russian National Research Medical University	0.648	-2.131	0.000	0.714	1.1	4.3	7.6
3. I.P. Pavlov First Saint Petersburg State Medical University	0.731	-1.865	0.000	0.723	1.8	5.4	9.1
4. I.I. Mechnikov North-Western State Medical University	0.815	-2.119	0.000	0.841	2.0	6.0	10.1
5. A.I. Yevdokimov Moscow State University of Medicine and Dentistry	0.521	-1.574	0.000	0.781	1.0	3.6	6.2
6. Bashkir State Medical University	0.557	-1.426	0.000	0.687	1.4	4.1	6.9
7. Siberian State Medical University	0.711	-1.658	0.000	0.625	1.9	5.5	9.0
8. Privolzhsky Research Medical University	0.688	-1.613	0.000	0.565	1.8	5.3	8.7
9. Kazan State Medical University	0.592	-1.846	0.000	0.539	1.1	4.1	7.0
10. Volgograd State Medical University	0.648	-1.739	0.000	0.621	1.5	4.7	8.0
All universities					**2.0**	**5.8**	**9.6**

The results of the regression analysis show that for 10 Russian medical universities, the average value of the H-index in Google Scholar is lower than its average value in eLibrary.Ru approximately: a) by 3 for the level of the H-index in eLibrary.Ru=5; b) by 4.2 for the level of the H-index in eLibrary.Ru=10; c) by 5.4 for the level of the H-index in eLibrary.Ru=15. It follows that the citation of Russian-language works by Russian scientists in eLibrary.Ru significantly exceeds the citation rate in Google Scholar.

V. DISCUSSION

In this study, we proceeded from the assumption that the management and faculty of a modern university are in a constant search of ways to increase the efficiency of their current work [29] and of new directions in the use of assets [30] to create such value for the consumers of educational and scientific services [31] that would allow them to obtain monetary and other resources in exchange [32,33].

The feature of a specialized medical university, among other things, is that its training and research in a wide range of areas of medical science is based not only on the appropriate level of staffing, material, and technical support but also on such institutional factors of its development as a long tradition of training scientific personnel [34] and effective management approaches to the organization of the educational process and scientific research [35].

In our view, assessment of the effect of the development of research and innovation activity in a medical university should consider the following: availability of scientific schools and results of their activity; stability of publication activity, awards for the research and scientific-pedagogical work of employees, various state prizes, awards, etc.; research and training projects implemented by different departments with the same partner; number of original courses that are taught using original textbooks and manuals.

Our findings indicate that among scholars at the top specialized medical universities in the country, there is a correlation between the h-indexes in Sc and GS consistent with the conclusions of foreign research on the works of academics in other fields of science [26,27]. Thus, the pattern we found in the correlation of the h-index scores in Sc and GS can be considered characteristic not only of Russian researchers.

However, formalized scientometric evaluation has been criticized by many academics from different countries. In the United Kingdom, there is a growing initiative to use impact factor indicators more critically to evaluate scientific research. For example, support for the Declaration on Research Assessment (DORA), which calls for a reassessment of the role of the impact factor in the organization and stimulation of research, has been announced by the Research Councils UK, a body that coordinates research policy in the UK [22].

Considerable criticism is levied on the business model of large publishing conglomerates, which have a de facto monopoly position in the academic press market [27].

In counterpoint to these conclusions, we cannot but respond that it is appropriate to use the citation index to assess the fundamental contribution of a given publication to science and to reflect the views of the academic community. However, to involve the wider public (heads of grant funds, publishers, scientific organizations, individual researchers, and officials) in the evaluation and discussion of the issue, it is advisable to use different groups of scientometric indicators, especially when it comes to a quick evaluation of works published too recently to be cited.

We fully agree with the thesis that bibliometric methods for assessing the level of authority of publications and authors' citations should not be used as sole and self-sufficient methods. It would be advisable to introduce alternative approaches to evaluating the quality of scientific results and monitoring the development of the scientific environment by thematic sections of the relevant field of knowledge. Thus, for example, M.J. Cobo et al. [24] criticize the fact that the current methods ignore a substantial number of research outputs that are left out of the analysis in citation indices, as well as scientific papers published online.

As proposed by R.Sh. Rakhmatulina [36], an expedient solution would be the use of alternative metrics, i.e., alternative systems for evaluating scientific content that allow grant managers to select promising projects for investment. The key function of altmetrics is to identify publications that are of practical value and worth funding but are insufficiently cited despite covering topics relevant to science and promising directions for further research.

Alternative metrics also suggest the possibility of using alternative indicators, such as social media mentions, downloads, and shares, to assess the broader impact and public participation in scientific research [37].

Another alternative approach to assessing the quality of scientific output and monitoring the development of the scientific environment is to assess the ability of an educational institution to gain recognition from research communities and gain reputation. In this case, the main facts under consideration are participation in the joint work of national and international research projects, national and international cooperation with other educational institutions, participation in national and international networks, joint organizations, and scientific societies, organization of the infrastructure of scientific programs, organization of national and international symposia, attractiveness for researchers and doctoral students, prizes and distinctions awarded to university employees, invitations to scientific events, participation in scientific committees of symposia or conferences and scientific supervisory bodies, the scientific quality of peer review in journals and collections in which staff members participate as editors, selectivity and importance of scientific issues discussed at international events with their participation, the level and reputation of scientific publications where their works are published.

It is also possible to evaluate the various activities and achievements through which research contributes to the innovation process and has an impact on the economy, society, or culture. The facts that should be considered correspond to activities outside the research community and can be divided into the following groups:

- results aimed at non-academic performers, namely: articles in professional journals, reviews intended for scientists, study and revision of reports aimed at public or private decision-makers, contribution to standards and guidelines (for example, clinical protocols), conceptual tools and models for decision-making, industry patents and licenses, methods and know-how, clinical studies, events that promote scientific culture, continuing education, public debate;

- the impact of research and partnerships on contribution to small businesses and, generally, participation in supporting or developing employment in the economic sector, innovations (new products, methods, processes, etc.), healthcare, creation of new structures or professional organizations, overview of the impact of technological innovation.

The following quality indicators can be assessed: originality of transferred methods, products, and technologies (for example, contribution to innovation), relationship with the latest scientific knowledge, quality and success of dissemination (choice of medium, result for methods and products, impact on target audience, connection with professional training, etc.), the presence of common results with non-academic partners (articles, patents, etc.), usefulness of transferred knowledge and technologies, innovative startups, quality and duration of partnerships, influence on the economic, social, or cultural position of partners and the emergence of innovations for the scientific community.

For example, one of the main tools for monitoring the quality of research in the UK (Research Excellence Framework, REF) proposes the following criteria for assessing their quality: results, impact on the environment and the research environment. In this case, the results are assessed in terms of their originality and significance. The impact on the environment is assessed in terms of achievements and significance for the economy, society, culture, public policy, health, and quality of life. The influence on the research environment is assessed in terms of the quality and development of the research base, scientific teams and their achievements, support for interdisciplinary research, and attitude towards the private and public sectors.

Investigating the issue of supporting science in the current conditions, researchers rightly conclude that "only professional expertise can give a detailed impartial assessment of scientific results and merits, and scientometric indicators serve as a tool to help experts make decisions" [14]. Thus, the most effective way to evaluate research is the expert method, and the most common form of quality assessment is expert assessment. Experts are selected from among the most qualified specialists in the research field.

The result of such a professional examination is an expert opinion, which, as a rule, consists of four sections. The first section examines the project by topic and discipline, the completeness of the application of world practice in substantiating the issue, subject, constructive beliefs, goals, and objectives of research or development, and the completeness of the expected cognitive results. It also substantiates the scientific novelty and originality of the expected results, significance, completeness of disclosure and validity of newly created approaches, methods, and techniques of scientific research and the prospects of their use as interdisciplinary, the pragmatic significance of the expected consequences of work and training, etc.

The second section is focused on refining and using scientific experience on a certain topic, in particular, publications on the topic in journals indexed in Web of Science and Scopus, monographs and their sections, defended dissertations, etc.

The third section provides indicators of expected results (for example, articles planned in journals and included in the list of professional publications, etc.). The fourth section describes the general result of the three previous sections.

The analysis conducted in this paper demonstrates the possibility and feasibility of using GS to assess the results of research and innovation activities of medical universities' staff. The indisputable advantage of GS in comparison with commercial Sc and WoS is that it considers the indexing of publications in Russian. All scientific journals also publish English-language abstracts of Russian-language articles, which virtually eliminates the issue of access to them by foreign readers.

VI. CONCLUSION

The conducted study confirms the hypothesized connection between the h-index values in Sc and GS for scientists from medical universities. This approach makes it possible to rationally spend the funds of universities and their staff and is compatible with the principles of functioning of an entrepreneurial university. Given the aforesaid findings, the Ministry of Education and Science of Russia can use free GS to carry out the scientometric evaluation of the work of medical scientists employed in specialized medical universities.

As limitations of the study, we believe it is necessary to note two components. The first one is that the papers selected for the analysis were those written by scholars from medical universities, which prevents us from extrapolating the feasibility of using GS for the scientometric evaluation of research work by scientists in other scientific fields. The second limitation is comments on the specificity of the calculation of the h-index in GS, due to the possibility to manipulate its value.

Regarding further research prospects, we believe that due to the current information restrictions faced by Russia, the issue of the scientific value of online resources is highly urgent, maybe even somewhat overdue, at today's stage of development of information society and necessitates merely the development of appropriate reliable methods. Prospective research in this area should focus on the further development of both the theoretical base and factual evidence demonstrating the possibilities of the GS search engine for the objective evaluation of scientific results achieved by the staff of Russian universities.

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