

**Цитирование, как показатель востребованности исследований по тематике
"травматология и ортопедия", на примере публикаций Центра Илизарова**

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***Scientific citation as an indicator of research relevance in traumatology and orthopedics
on the example of the publications of the Ilizarov Center***

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The authors of the study analyzed the works on traumatology and orthopedics published by the employees of the Ilizarov Center in the period between 2008 and 2018 and their citations in scientific journals that are part of the Scopus bibliographic database. The total number of publications, the number of cited articles and the number of citations for each article in Scopus were assessed. Ranking and categories of journals that published and cited these articles, the dependence of rating indicators of publishing and citing journals, the dependence of the number of citations on the origin of journals (foreign or Russian) and on the affiliation of the authors who cited the Center's articles were analyzed.

Keywords: orthopaedics, traumatology, Ilizarov method, bibliometrics

INTRODUCTION

According to Elsevier database, the number of studies published by Russian scientists in the journals indexed by Scopus exceeded 98,000 in 2018. Indicators of the SciVal analytical tool, the source of which is the Scopus database, have shown an increase in the publication activity of Russian researchers over the past 10 years. Unfortunately, medicine and, in particular, traumatology and orthopedics are not among the top most reported subject areas represented by Russian scientists in the publications available.

The topic of publication activity of domestic orthopedic and traumatology investigators was raised in the journal *Traumatology and Orthopedics of Russia (Travmatologia i ortopedia Rossii)* [1]. The publication activity of the staff of the Russian Ilizarov Scientific Center for Restorative Traumatology and Orthopaedics (Ilizarov Center)

of the Ministry of Health of Russia was appreciated in this article.

According to the studies published [2–9], the Ilizarov method, which is the main scientific interest for the researchers of the Ilizarov Center, remains one of the most frequently used bone reconstruction tools.

We decided to continue the topic and conducted a bibliometric analysis of publications of the Ilizarov Center researchers and their citations in the journals indexed by Scopus.

The purpose of the work was to assess the interest of the scientific orthopedic community to the articles published by the employees of the Ilizarov Center, and, accordingly, to the studies on transosseous osteosynthesis, that is shown by relevant publications and citations in the Russian and foreign scientific literature.

MATERIAL AND METHODS

Publications of the Ilizarov Center staff in the scientific journals, indexed by the abstract and bibliographic database Scopus, for the period

from 2008 to 2018 were the material for the analysis. A search in the Scopus database using the organization identification number AF-ID

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(Russian Ilizarov Scientific Center for Restorative Traumatology and Orthopedics 60105476) identified 396 documents, of which 360 were articles (document type – *Article*), 8 reviews (*Review*), 20 books and chapters from books (*Book and Book Chapter*), and 8 conference papers (*Conference Paper*).

Three hundred and nine (309) journal articles on the topics of traumatology and orthopedics were selected for the analysis. These articles were divided into two groups: articles in foreign journals and articles in Russian journals. Articles translated from Russian for journals that have a foreign publisher were included into the second group.

RESULTS

In the period studied, sixty nine (69) articles were published in foreign journals, indexed by Scopus, and 238 articles in Russian journals, indexed by Scopus. Articles published in foreign journals were cited 243 times while articles published in Russian journals only 102 times.

Group 1. Articles published in foreign journals indexed by Scopus

We found that 63.8 % of the articles published between 2008 and 2018 in foreign journals, included in the Scopus database, were cited (Table 1). Most cited articles were prepared jointly with foreign scientists. This fact confirms the data of Scopus that citation of joint publications published by Russian and foreign researchers exceeds (sometimes significantly) the world average. Also, quite high was the proportion of the cited articles prepared jointly with Russian scientists from other institutions.

Average number of citations per one article published and average number of citations per one article cited were greater for a group of articles with single affiliation (*Russian Ilizarov Scientific Center for Restorative Traumatology and Orthopedics*).

A two-to-three year delay dependence of the maximum of citation from the year of publication of the work was revealed. By the beginning of 2019, the maximum number of citations accounted for the articles published in the period 2012-2015 (**Fig. 1**).

Authors citing the works of the Ilizarov Center staff were:

- foreign authors;
- Russian authors, including:
 - employees of the Ilizarov Center;
 - authors of other RF institutions;
- authors of the articles (self-citing).

Table 1

Citation of the articles published in foreign journals indexed by Scopus

Indicators		Groups of articles			Total
		With single affiliation	Joint studies with foreign authors	Joint studies with Russian authors	
Number of published articles		43	18	8	69
Number of articles cited	Absolute number	24	14	6	44
	%	55.8 %	77.7 %	75.0 %	63.8 %
Number of citations		170	50	23	243
Average number of citations per article published		4	2.8	2.9	3.5
Average number of citations per one articles which was cited		7.1	3.6	3.8	5.5
Range of citations per one articles cited		1–30	1–7	2–10	1–30

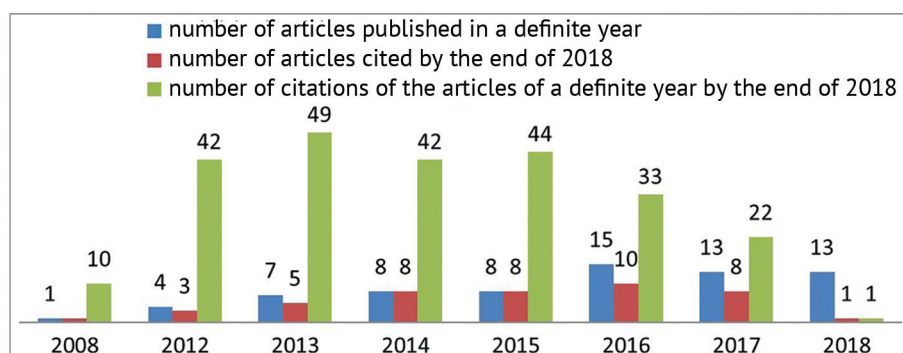


Fig. 1 Bibliometric indicators of articles, published in foreign journals indexed by Scopus

The analysis showed that the highest number of citations of the articles published in the period from 2008 to 2018 by the employees of the Ilizarov Center was found in the publications of foreign authors (Table 2). Citation by Russian authors who are not employees of the Ilizarov Center was minimal.

The analysis found the articles with the highest number of citations (five and more) and revealed the topics of the greatest interest. Those were 16 articles published within the period of 2008 to 2018 which were cited 182 times (Table 3). Their share was 75 %

of all citations in the period under survey. Eight articles of this group were written only by the authors from the Ilizarov Center [10–17]; two articles were co-authored by an Indian orthopaedic surgeon who at the time of their preparation was training at the Ilizarov Center [18, 19]. Five articles were prepared in collaboration with scientific and educational institutions of other countries [20–24], and one article with Russian scientists from another institution [25].

The articles of this group were also cited more by foreign authors (Table 4).

Table 2

Groups of authors who cited the articles of the Ilizarov Center in foreign journals indexed by Scopus

Groups of citing authors	Number of citations	
	Number	%
Foreign authors	134	55.1
Russian authors	31	12.8
<i>Ilizarov Center employees</i>	26	10.7
<i>Authors of other RF institutions</i>	5	2.0
Self-citing	78	32.1
Total	243	100

Table 3

List of most cited articles

#	Authors	Journal	Year	Number of Scopus citations	Number in the reference list
1.	Gubin, A.V., Borzunov, D.Y., Malkova, T.A.	International Orthopaedics	2013	30	[10]
2.	Borzunov, D.Y.	International Orthopaedics	2012	23	[11]
3.	Shevtsov, V.I., Danilkin, M.Y.	International Orthopaedics	2008	10	[12]
4.	Popkov, A., Aranovich, A., Popkov, D.	International Orthopaedics	2015	10	[13]
5.	Borzunov, D.Y., Chevardin, A.Y., Mitrofanov, A.I.	International Orthopaedics	2016	10	[14]
6.	Borzunov, D.Y., Chevardin, A.V.	International Orthopaedics	2013	8	[15]
7.	Gubin, A.V., Borzunov, D.Y., Marchenkova, L.O., Malkova, T.A., Smirnova, I.L.	Strategies in Trauma and Limb Reconstruction	2016	7	[16]
8.	Kliushin, N.M., Ermakov, A.M., Malkova, T.A.	International Orthopaedics	2017	5	[17]
9.	Novikov, K.I., Subramanyam, K.N., Muradisinov, S.O., Novikova, O.S., Kolesnikova, E.S.	Clinical Orthopaedics and Related Research	2014	13	[18]
10.	Borzunov, D.Y., Balaev, P.I., Subramanyam, K.N.	Indian Journal of Orthopaedics	2015	5	[19]
Joint articles with foreign authors					
11.	Lascombes, P., Popkov, D., Huber, H., Haumont, T., Journeau, P.	Orthopaedics and Traumatology: Surgery and Research	2012	14	[20]
12.	Popkov, D., Lascombes, P., Berte, N., Hetzel, L., Baptista, B.R., Popkov, A., Journeau, P.	Skeletal Radiology	2015	12	[21]
13.	Popkov, D.A., Popkov, A.V., Kononovich, N.A., Barbier, D., Ceroni, D., Journeau, P., Lascombes, P.	Orthopaedics and Traumatology: Surgery and Research	2014	7	[22]
14.	Popkov, D., Journeau, P., Popkov, A., Pedetour, B., Haumont, T., Lascombes, P.	Orthopaedics and Traumatology: Surgery and Research	2012	5	[23]
15.	Vincelet, Y., Journeau, P., Popkov, D., Haumont, T., Lascombes, P.	Orthopaedics and Traumatology: Surgery and Research	2013	5	[24]
Joint articles with Russian authors					
16.	Popkov, A.V., Kononovich, N.A., Gorbach, E.N., Tverdokhlebov, S.I., Irianov, Y.M., Popkov, D.A.	Scientific World Journal	2014	10	[25]

Table 4

Authors that referred to the 16 most cited articles

Group	Number of citations	
	Absolute number	%
Foreign authors	102	56.1
Russian authors	21	11.5
<i>including authors of the Ilizarov Center</i>	18	9.9
<i>Authors from other RF institutions</i>	3	1.6
Self-citations	59	32.4
Total	182	100

None of the Russian authors, who are not employees of the Ilizarov Center, cited the publications of this group in their articles published in foreign journals.

The authors of publications in the Russian journals, indexed by Scopus, cited the works of this group 14 times; 12 citations were found in the publications of the Ilizarov Center researchers, including the authors of the articles themselves, and only three times these publications were cited in Russian journals such as *Pediatric Orthopedics*, *Traumatology and Rehabilitation Surgery* and *Polytrauma* by Russian authors who are employees of other institutions of the Russian Federation.

The overwhelming number of references to these works was found in the articles published in foreign journals, including the journals with a rating of more than 75 percentiles (Table 5).

We tried to find the dependence of the ranking of the journals that published and cited the articles. We were unable to identify it on a small sample of 16 articles and 182 citations (**Fig. 2**).

There were three categories of specialized journals that published the most cited articles: Orthopaedics & Sports Medicine; Radiology, Nuclear Medicine and Imaging; General Environmental Science. However, fourteen (14) out of 16 articles were published in journals under the category *Orthopedics and Sports Medicine* (**Fig. 3**).

The journals that cited these works belong to 18 categories of specialized publications. The largest number of references (115) was also found in the journals belonging to the *Orth & Sports Medicine* category (**Fig. 4**).

Table 5

Distribution of journals with references to 16 most cited articles

Publications from Scopus database	Number of citing publications	
	Absolute number	%
Foreign journals	158	86.8
<i>with ranking of more than 75 percentile</i>	76	41.8
<i>with ranking from 50 to 75 percentile</i>	42	23.0
<i>with ranking of less than 50 percentile</i>	40	22.0
Russian journals	14	7.7
Books (#Book, #Book Chapter)	9	4.9
Conference Paper	1	0.5
Total	182	100

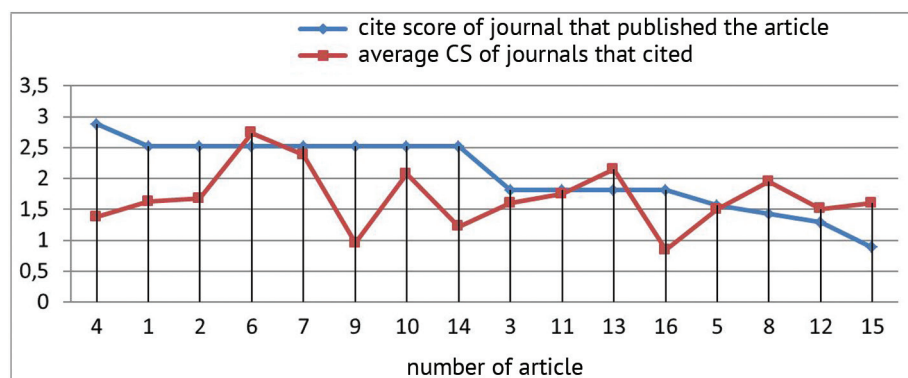


Fig. 2 Dependence of the ranking of the journals that published and cited the articles

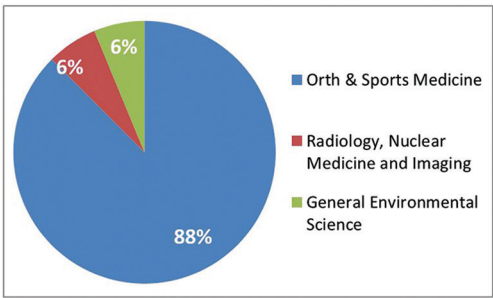


Fig. 3 Diagram of the categories of the journals that published the most cited articles

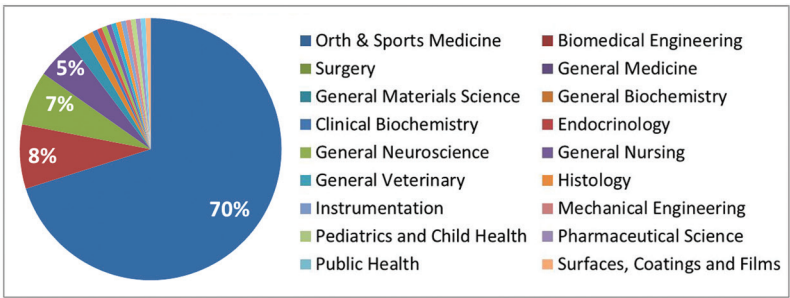


Fig. 4 Diagram of the journal categories of the articles that cited Center's publications

Group 2. Articles published in the Russian journals indexed by Scopus

In the period from 2008 to 2018 there were 238 articles published by the Ilizarov Center staff in Russian journals, 92 % of them had the only affiliation (*Russian Ilizarov Scientific Center for Restorative Traumatology and Orthopaedics*). The maximum portion of the cited articles was a group of joint publications with Russian scientists from other institutions (Table 6).

The indicators "number of citations" and, accordingly, "the average number of citations per article" and "the average number of citations per cited article" are much lower than the same indicators for a group of articles published in foreign journals, indexed by Scopus.

The most cited were studies published in 2014-2015 (Fig. 5).

The articles of the Ilizarov Center's authors published in the period under survey were cited 102 times, most of the citations are self-citations. The number of citations by Russian authors that are employees of other institutions of the Russian Federation is the lowest (Table 7).

Most of the cited articles were published in the journals that reflect the problems of fundamental medicine (*Bulletin of the Russian Academy of Medical Sciences, Bulletin of Experimental Biology and Medicine, Morphology, Human Physiology*), and the Russian authors who cited these works are morphologists, immunologists, specialists in biomechanics, but, by no means, trauma- or orthopedic surgeons.

Table 6

Citation indicators of articles published in Russian journals, indexed by Scopus

Indicators		Article groups			Total
		Single affiliation	Joint articles with foreign authors	Joint articles with Russian authors	
Number of articles published		220	4	14	238
Number of articles cited	number	53	1	5	59
	% from the total	24	25	60	25
Number of citations		91	3	8	102
Average number of citations per one article		0.41	0.75	0.57	0.43
Average number of citations per one article cited		1.72	3	1.6	1.73
Range per one article cited		1 – 8	3	1 – 2	1 – 8

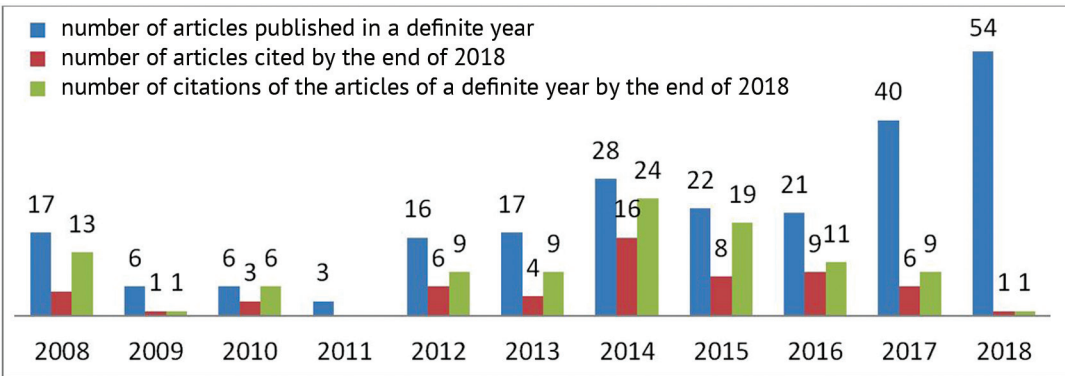


Fig. 5 Bibliometric indicators of articles, published in Russian journals indexed by Scopus

Table 7

Authors, citing the articles in the Russian journals, indexed by Scopus

Group	Number of citations	
	Number	%
Foreign authors	30	29.4
Russian authors, including	25	24.5
<i>Authors of the Ilizarov center</i>	18	17.6
<i>Authors from other RF institutions</i>	7	6.9
Self-citing	47	46.1
Total	102	100

The analysis revealed a sufficient interest of the foreign orthopedic scientific community to the articles published by the staff of the Ilizarov Center and the absolute lack of demand for them in the Russian scientific literature.

It could be explained by the fact that the problems disclosed by the studies of the Ilizarov Center and to a great extent related to the research in the field of the Ilizarov transosseous osteosynthesis, are unique and have not been studied by specialists of other Russian orthopedic institutions. In part, it is due to the lack of adequate support for the

transosseous osteosynthesis technology from commercial partners and the state. Unfortunately, the provision of high-tech care in traumatology and orthopedics among Russian specialists is mainly associated with total arthroplasty of the joints.

However, the search with the key word *Ilizarov* in the Scopus database in April 2019 identified a total of 3,417 documents with an average of 120 publications per year. Therefore, the interest to the Ilizarov method and its modifications remains relevant in the world orthopaedic literature.

CONCLUSION

The analysis resulted in the following conclusions:

- Articles of the Ilizarov Center employees are published and cited mainly in the journals belonging to the category of specialized orthopedic journals Orth & Sports Medicine;
- Articles of the Ilizarov Center employees are cited by foreign authors and are not cited by Russian authors from other institutions of the Russian Federation;

- Articles, published in the foreign journals indexed by Scopus, are cited more than articles published in Russian journals, indexed by Scopus;
- Joint publications of the Ilizarov Center researchers and their foreign colleagues show the biggest number of citations;
- There is no dependence on the ranking of the journals that published and cited the articles.

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