Proceedings of the Pakistan Academy of Sciences: B. Life and Environmental Sciences 58(3): 43-54 (2021)

ISSN (Print): 2518-4261; ISSN (Online): 2518-427X
http://doi.org/10.53560/PPASB (58-3)661

Pakistan Academy of Sciences

Research Article

Pakistan has the 2nd Highest Growth Rate in Medical Sciences Research Publications for the Year 2019-2020: Comparison with 46 Countries

Waseem Hassan*, and Amina Ara

Institute of Chemical Sciences, University of Peshawar, Peshawar 25120, Khyber Pakhtunkhwa, Pakistan

Abstract: In 2020, Forty-Six (n=46) countries have published at least three thousand research documents in the field of Medical Sciences. Based on the number of publications, the top three countries are United States (202373/26.65 %), China (116155/15.30 %), and United Kingdom (58892/7.75 %). We also calculated the relative growth rate (GR) (for the year 2019-2020) of 46-countries. The highest GR was recorded for Saudi Arabia (n=44.31), Pakistan (n=37.58), and Nigeria (n=37.36). We extended the idea and explored the publication details of Pakistan. From 1947 to 2000, Pakistan published 4378 research documents, while from 2001 to 2020, it published 41889 research documents. Based on the number of publications, the list of top 50 researchers, universities, and sources are described. Some of the prominent features for this astonishing increase in research publication output are the establishment of the higher education commission (HEC) Islamabad, an increase in the number of research scholars, faculty, universities, national educational budget, funding, and international collaboration. Although based on the number of publications Pakistan holds 42nd position in the world. But it has a meager share of 0.19 % in the total global production (n=23905729). This confirms that strong policies, planning, and management are required to improve the overall research progress.

Keywords: Scopus, Medical Sciences, Research Growth Rate, Pakistan.

1. INTRODUCTION

Numerous studies reported the research publication and productivity of various countries in different disciplines like nursing, transplantation, pharmacology, and biomedical sciences, etc. For example, United States was found to be the most prolific and productive country in research contributions in almost every field of science. The bibliometric analysis of the US has been extensively reported in different areas, such as neuroimaging [1], natural hazards [2], cocaine intoxication [3], and tuberculosis [4], etc. In the current scenario of rapidly increasing research publications, Australia was ranked as one of the most productive countries. This has been confirmed by the bibliometric reports of Australia's involvement in nonspecific low back pain [5], and medicine [6]. In Europe, Italy was found to be one of the top productive countries. There are several bibliometric studies for Italy in different special topics including COVID-19 [7] and pathology [8]. While Neudí *et al.* [9] highlighted that Brazil has one of the highest counts of publications. Additionally, various bibliometric studies have been reported on malocclusion, imaging, and morphology, on dental material, leishmaniasis [10], economics [11]. In Asian countries, India is one of the top-ranked countries in research publication and productivity in the past decade. The role of India in engineering and technology [12], oncology [13], etc. has been confirmed by bibliometric studies. Similarly, numerous studies have shown the contribution of Turkey in neuroscience [14], mathematics [15], and breast reduction [16]. A holistic summary through bibliometric analysis for Canada is also reported, where the top publications in forensic sciences [17], spinal cord injury [18] are reported.

Similarly, there are a few bibliometric studies

Received: July 2021; Accepted: September 2021
*Corresponding Author: Waseem Hassan <waseem_anw@yaho.com>

about different fields in Pakistan. For example, Bajwa and Yaldram reported the history and development of biotechnology research in Pakistan. The authors covered the publication history from 1980 to 2011. The authors reported that in 1980, there were only 15 publications in 1980 which increased to 3273, with an average growth rate of 22 %. The authors extracted publications data from Scopus and they reported the growth rate and doubling time of publications [19]. While, Siddique et al., reported the 62 years (from 1957–2018) of research in library and information science in Pakistan [20]. The authors provided details about the most productive organizations, authorship, collaboration pattern, and the most preferred journals. In the same vein, Ikram et al. performed the bibliometric analysis of social sciences in Pakistan from 1961 to 2019 [21]. The authors found 9,292 papers on social sciences with an average of 157.49 papers per year in the Scopus database. The most productive authors, departments, and sources are described in detail. There is another study, where the author reported bibliometric analysis of computer science literature of Pakistan from 2000 to 2017. They also highlighted the top contributing authors and departments [22].

The present research study is designed to explore the relative growth of the rate of the world (for the year 2019-2020). We will also highlight the contribution of Pakistan and its top-ranked researchers and institutions.

2. MATERIALS AND METHODS

2.1 Ethics Statement

The study did not involve human or non-human subjects. Therefore, neither approval by the institutional review board nor informed consent was required.

2.2 Study Design

This was a bibliometric study of a specific topic from a literature database.

2.3 Data Sources/Measurement

On 11th May, the data was retrieved from Scopus, one of the largest databases in the world. In the advanced search field, we selected the subject of medicine. In other words, the code was SUBJAREA(MEDI). According to Scopus, the following subjects are classified under it.

Medicine (all), medicine (miscellaneous), anatomy, anesthesiology and pain medicine, cardiology and cardiovascular medicine, critical care and intensive care medicine, complementary and alternative medicine, dermatology, drug guides, embryology, emergency medicine, endocrinology, diabetes, and metabolism, epidemiology, family practice, gastroenterology, genetics (clinical), geriatrics and gerontology, health informatics, health policy, hematology, hepatology, histology, immunology and allergy, internal medicine, infectious disease, microbiology (medical), nephrology, neurology (clinical), obstetrics and gynaecology, oncology, ophthalmology, orthopedics and sports medicine, otorhinolaryngology, pathology and forensic medicine, pediatrics, perinatology and child health, pharmacology (medical), physiology (medical), psychiatry and mental health, public health, environmental and occupational health, pulmonary and respiratory medicine, radiology nuclear medicine and imaging, rehabilitation, reproductive medicine, reviews and references (medical), rheumatology, surgery, transplantation, and urology. It is important to note that we only focused on research articles and reviews. The publications data of 2021 was also ignored in the analysis.

3. RESULTS AND DISCUSSION

In 2019, the world has produced 638026 research publications. Based on the number of publications and % share, the top ten countries are United States (177048/27.8 %), China (86580/13.6 %), United Kingdom (50730/7.9 %), Germany (38401/6 %), Italy (30942/4.8 %), Japan (31938/5 %), Canada (30549/4.7 %), Australia (27221/4.2 %), France (24998/2.9 %) and India (23575/2.6 %).

While in 2020, total publications were found to be 759420. The top ten countries are United States (202373/26.65 %), China (116155/ 15.30 %), United Kingdom (58892/7.75 %), Germany (43747/5.76 %), Italy (39966/5.26 %), Japan (36093/4.75 %), Canada (34395/4.53 %), Australia (31194/4.11%), France (28827/3.80 %)

and India (28365/3.74 %).

For growth rate calculations, we selected those countries which have published at least three thousand research documents. Forty-six (n=46) meet the threshold. The top ten countries are, Saudi Arabia (n=44.31), Pakistan (n=37.58), Nigeria (n=37.36), China (n=34.16), Colombia (n=32.62), Egypt (n=31.73), Mexico (n-29.95), Italy (n=29.16), Singapore (n=27.79) and Malaysia (n=25.04). The growth rates of all 46-countries with the number of publications (for the year 2019 and 2020) is described in Table 1.

3.1 Focus on Pakistan

Since Pakistan occupied 2nd Position, this further motivated us to explore its entire publication

Table 1. The number of research publications (NoP) and relative growth rates (RGR) of 46 countries.

S#	Country	NoP 2019	NoP 2020	2019-2020 RGR
1.	United States	177048	202373	14.30
2.	China	86580	116155	34.16
3.	United Kingdom	50730	58892	16.09
4.	Germany	38401	43747	13.92
5.	Italy	30942	39966	29.16
6.	Japan	31938	36093	13.01
7.	Canada	30549	34395	12.59
8.	Australia	27221	31194	14.60
9.	France	24998	28827	15.32
10.	India	23575	28365	20.32
11.	Spain	22612	27488	21.56
12.	Netherlands	20012	22978	14.82
13.	Brazil	17230	21409	24.25
14.	South Korea	18264	20660	13.12
15.	Turkey	13682	17057	24.67
16.	Iran	13902	16809	20.91
17.	Switzerland	13770	16139	17.20
18.	Russian Federation	12008	13841	15.26
19.	Sweden	11766	13286	12.92
20.	Belgium	9225	10961	18.82
21.	Denmark	8715	10050	15.32
22.	Poland	8400	9273	10.39
23.	Taiwan	7468	8531	14.23
24.	Austria	6284	7557	20.26
25.	Egypt	5272	6945	31.73
26.	Israel	5568	6710	20.51
27.	Saudi Arabia	4617	6663	44.31
28.	Mexico	5081	6603	29.95
29.	Norway	5961	6562	10.08
30.	South Africa	5439	6519	19.86
31.	Portugal	5111	6312	23.50
32.	Greece	5016	5939	18.40
33.	Singapore	4156	5311	27.79
34.	Pakistan	3763	5177	37.58
35.	Ireland	4195	5173	23.31
36.	Thailand	4064	4912	20.87
37.	Malaysia	3886	4859	25.04
38.	Finland	4306	4788	11.19
39.	New Zealand	3951	4587	16.10
40.	Hong Kong	3686	4502	22.14
41.	Indonesia	3749	4478	19.45
42.	Czech Republic	3888	4205	8.15
43.	Chile	2918	3614	23.85
44.	Colombia	2707	3590	32.62
45.	Argentina	2905	3573	22.99
46.	Nigeria	2385	3276	37.36

history since independence i.e. 1947. To the best of our knowledge, this is the 1st report which has described the research growth of Pakistan in medicine (for 2019-2020). Pakistan has produced 52333 research documents majorly comprising of articles (n=42946), reviews (n=3356), letters (n-2373), conference papers (n-1145), editorials (n=1095), notes (n=545), book chapters (n=498), short surveys (n=183), errata (n=154), books (n=24), retracted documents (n=5), abstract reports (n=1) and undefined documents (n=8).

For further data acquisition, we focused on research articles and reviews (n=46302). For simplicity, we divided the total years into two eras.

From 1947 to 2000, Pakistan published 4378 research documents. It also includes those documents (n=35) which are published before 1947. Based on the number of publications, the top ten authors in this era were; Zuberi, S.J. (n=74), Bhutta, Z.A. (n=68), Qureshi, H. (n=48), Qureshi, I.H. (n=46), Khurshid, M. (n=36), Ahmad, V.U. (n=35), Malik, I.A. (n=35), Khan, H.A. (n=34), Ahmed, W. (n=32), and Alam, S.E. (n=32). Institutionally, Jinnah Postgraduate Medical Centre, Karachi, published the highest number of documents (n=456), followed by The Aga Khan University Hospital (n=450), The Aga Khan University (n=401), University of Karachi (N=282), Pakistan Institute of Nuclear Science and Technology (n=238), Dow Medical College Pakistan (n=179), King Edward Medical University Lahore (n=163), University of Punjab, Lahore (n=113), Mayo Hospital Lahore (n=104), and Liaquat National Hospital (n=102).

From 2001 to 2020, Pakistan published 41889 research documents. The highest documents are published by Bhutta, Z.A. (n=573), followed by Ahmad, W. (n=188), Jafri, W. (n=168), Abbas, Z. (n=155), Pervez, S. (n=124), Goldenberg, R.L. (n=118), Choudhary, M.I. (n=114), Kayani, N. (n=112), Hasan, R. (n=111) and Saleem, S. (n=110). The top ten institutes in this era are The Aga Khan University (n=4340), The Aga Khan University Hospital (n=3883), Dow University of Health Sciences Pakistan (N=1599), Quaid-i-Azam University (N=1458), University of Punjab, Lahore (N-1249), Liaquat National Hospital (N=1192), University of Karachi (N=1102), King Edward Medical University Lahore (n=1016), Khyber Medical College (N=973), and Mayo Hospital Lahore (n=962), or collectively (from 1947 to 2020) based on the number of publications, the top ten authors are Bhutta, Z.A. (n=641), Ahmad, W. (N=191), Jafri, W. (n=188), Abbas, Z. (n=183), Pervez, S. (n=150), Choudhary, M.I. (N=142), Kayani, N. (n=136), Goldenberg, R.L. (n=118), Hasan, R. (n=118), and Hamid, S. (n=117). The list of the top 50-authors is provided in Table 2. While the highest affiliations were recorded for The Aga Khan University (n=4741), The Aga Khan University Hospital (n=4333), Dow University of Health Sciences Pakistan (n=1599), Quaid-i-Azam University (n=1525), University of Karachi (n=1384), University of Punjab, Lahore (n=1362), Liaquat National Hospital (n=1294), Jinnah Postgraduate Medical Centre, Karachi (n=1227), King Edward Medical University Lahore (n=1179) and Mayo Hospital Lahore (n=1066). The list of top 50-universities is provided in Table 2. While

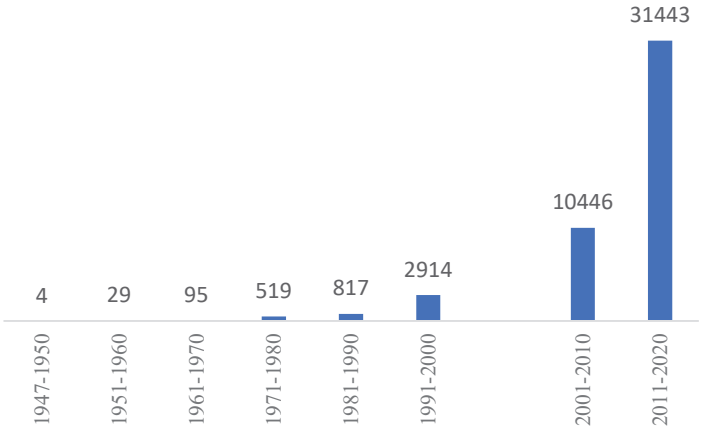

Fig. 1. List of publications for each decade (from 1947 to 2020).

Table 2. The list of top 50 authors and institutes of Pakistan. The names of the universities do not describe the affiliations of the authors.

Top Authors			Top Institutions		
S#	**Author Name**	**NoP***	S#	**Affiliations**	**NoP***
1.	Bhutta, Z.A.	641	1.	The Aga Khan University	4741
2.	Ahmad, W.	191	2.	The Aga Khan University Hospital	4333
3.	Jafri, W.	188	3.	Dow University of Health Sciences Pakistan	1599
4.	Abbas, Z.	183	4.	Quaid-i-Azam University	1525
5.	Pervez, S.	150	5.	University of Karachi	1384
6.	Choudhary, M.I.	142	6.	University of the Punjab, Lahore	1362
7.	Kayani, N.	136	7.	Liaquat National Hospital	1294
8.	Goldenberg, R.L.	118	8.	Jinnah Postgraduate Medical Centre, Karachi	1227
9.	Hasan, R.	118	9.	King Edward Medical University Lahore	1179
10.	Hamid, S.	117	10.	Mayo Hospital Lahore	1066
11.	Khurshid, M.	113	11.	Khyber Medical College	1058
12.	McClure, E.M.	110	12.	Liaquat University of Medical and Health Sciences	938
13.	Saleem, S.	110	13.	COMSATS University Islamabad	937
14.	Wasay, M.	108	14.	Lady Reading Hospital	830
15.	Idrees, M.	107	15.	Dow Medical College Pakistan	713
16.	Riazuddin, S.	106	16.	University of Lahore	673
17.	Ahmad, Z.	104	17.	University of Agriculture, Faisalabad	652
18.	Basit, A.	104	18.	Pakistan Institute of Medical Sciences	633
19.	Shaikh, M.A.	102	19.	University of Veterinary and Animal Sciences Lahore	610
20.	Ahmad, M.	101	20.	National University of Sciences and Technology Pakistan	609
21.	Qureshi, H.	101	21.	Services Institute of Medical Sciences Lahore	580
22.	Rehman, R.	100	22.	Combined Military Hospital, Multan	580
23.	Shamim, M.S.	99	23.	Islamia University	558
24.	Kazi, T.G.	97	24.	University of Peshawar	555
25.	Das, J.K.	96	25.	University of Health Sciences Lahore	539
26.	Afridi, H.I.	95	26.	Shaukat Khanum Memorial Cancer Hospital and Research Centre	530
27.	Jabbar, A.	94	27.	King Saud University	528
28.	Zafar, A.	93	28.	Allama Iqbal Medical College	523
29.	Zuberi, S.J.	93	29.	Pakistan Institute of Nuclear Science and Technology	510
30.	Khan, M.S.	91	30.	Children's Hospital Lahore	494
31.	Zaidi, A.K.M.	90	31.	Baqai Medical University	471
32.	Gupta, R.	88	32.	Government College University Faisalabad	470
33.	Mubarak, M.	88	33.	Shifa International Hospital	443
34.	Ather, M.H.	87	34.	Jinnah Hospital Lahore	442
35.	Hussain, I.	87	35.	Organisation Mondiale de la Santé	439
36.	Gilani, A.H.	86	36.	London School of Hygiene and Tropical Medicine	428
37.	Abid, S.	85	37.	Sindh Institute of Urology and Transplantation	427
38.	Islam, M.	85	38.	Nishtar Medical College and Hospital	426
39.	Pasha, O.	83	39.	Bahauddin Zakariya University	419
40.	Carlo, W.A.	82	40.	Armed Forces Institute of Pathology Rawalpindi	418
41.	Hasan, S.H.	82	41.	Jinnah Sindh Medical University	381

S#	Author Name	NoP*	S#	Affiliations	NoP*
42.	Chomba, E.	81	42.	Ziauddin Medical University	378
43.	Malekzadeh, R.	81	43.	Ayub Medical College	376
44.	Khan, T.M.	80	44.	Army Medical College Pakistan	373
45.	Lassi, Z.S.	79	45.	Hospital for Sick Children University of Toronto	370
46.	Rahman, A.	79	46.	Khyber Medical University	367
47.	Riazuddin, S.	79	47.	Ziauddin University	351
48.	Ahmad, V.U.	78	48.	Shifa College of Medicine	336
49.	Bhutta, Z.	78	49.	Riphah International University	334
50.	Haroon, T.S.	78	50.	Johns Hopkins Bloomberg School of Public Health	323

*NoP: Number of Publications.

the per-year publications are described in Figure 1.

Mostly these documents are published in Journal of the Pakistan Medical Association (n=4380), Journal of the College of Physicians and Surgeons Pakistan (n=4116), Pakistan Journal of Medical and Health Sciences (n=3974), Medical Forum Monthly (n=3086), Pakistan Journal of Medical Sciences (n=1752), Journal of Ayub Medical College Abbottabad JAMC (n=1573), JPMA the Journal of the Pakistan Medical Association (n=1282), Journal of Postgraduate Medical Institute (n=749), Journal of Pakistan Association of Dermatologists (n=679) and Journal of the Liaquat University of Medical and Health Sciences (n=550). The details about the top 50 sources are provided in table 3.

It is worthy to note that Pakistan produced 90.54 % (or 41889) documents after 2001. Or in other words, only 9.46 % (4378) were published from 1947 to 2000. One of the fundamental questions is, why such an enormous rise in research output. This could be explained by some of the following reasons.

In 1947 there was only one University i.e. University of Punjab. According to Isani & Usman Ali, the 1st official education policy was introduced in 1956. In 1972, a new education policy was announced and in 1974, University Grants Commission was officially established by the act of parliament. Later some other major reforms and policies were introduced, for example, The National Education Policies (in 1979 and 1992) and in 1993 in eighth five-year plans for the national economy of Pakistan, the education was also focused [23-25].

The Higher Education Commission (HEC), Islamabad is a statutory body formed by the government of Pakistan in 2002. Initially, it was known as University Grants Commission (UGC), which was established in 1974. The HEC revolutionized science and higher education under the leadership of Prof. Atta-ur-Rahman when he was the Federal Minister of science & technology and later chairman of the Higher Education Commission with the status of Federal Minister. HEC introduced various and reforms which helped in improving the overall research culture and productivity. For example, In 2001-02, there were 74-universities, 5160-faculty members, and 276000-students. In 2017-18, the number of universities substantially increased to 186, with 56885 teachers, and 1575000 students. While in 2019-20 the total number of universities are 211. The total number of institutions are 317,323 with 50,292,570 students and 1,836,584 teachers. This shows a remarkable development.

This also significantly helped in research output. For example, from 1970 to 1999, there was only 1034 thesis in all subjects. The thesis production enormously increased and from 2000 to Jan 2020, 10,096 theses in all subjects are archived in the Pakistan research repository (PRR).

In 1975, the national education budget was 11.3 billion which increased to 72.3 billion in 2001. Later on, the budget augmented from 83.2 billion in 2003 to 315 billion in 2018.

After the establishment of HEC, the higher education budget for the years (2005-06, 2006-07, 2007-08, 2008-9 and 2009-10) also enormously increased from 21.38 to 28.74, 27.92, 32.18, and 44.00 billion, respectively.

From 1947 to 2000, only six (n=6) funding bodies have been acknowledged in at least ten

Table 3. The list of top 50 sources

S#	Source Title	NoP*
1.	Journal of the Pakistan Medical Association	4380
2.	Journal of the College of Physicians And Surgeons Pakistan	4116
3.	Pakistan Journal of Medical and Health Sciences	3974
4.	Medical Forum Monthly	3086
5.	Pakistan Journal of Medical Sciences	1752
6.	Journal of Ayub Medical College Abbottabad JAMC	1573
7.	JPMA the Journal of the Pakistan Medical Association	1282
8.	Journal of Postgraduate Medical Institute	749
9.	Journal of Pakistan Association of Dermatologists	679
10.	Journal of the Liaquat University of Medical and Health Sciences	550
11.	Journal of Medical Sciences Peshawar	523
12.	Pakistan Paediatric Journal	484
13.	Asian Pacific Journal of Cancer Prevention	334
14.	Pakistan Journal of Nutrition	274
15.	Tropical Journal of Pharmaceutical Research	248
16.	Journal of Radioanalytical and Nuclear Chemistry	233
17.	Anaesthesia Pain and Intensive Care	216
18.	BMJ Case Reports	208
19.	Eastern Mediterranean Health Journal	196
20.	Lancet	190
21.	Journal of Natural Products	182
22.	Jpmi Journal of Postgraduate Medical Institute	162
23.	BMC Complementary and Alternative Medicine	160
24.	Ecotoxicology and Environmental Safety	158
25.	BMC Public Health	156
26.	Medical Channel	152
27.	Microbial Pathogenesis	147
28.	Biological Trace Element Research	141
29.	Journal of Medical Sciences	136
30.	Virology Journal	132
31.	Microscopy Research and Technique	129
32.	International Journal of Environmental Research and Public Health	123
33.	Computer Methods and Programs in Biomedicine	115
34.	Frontiers in Microbiology	110
35.	Specialist	110
36.	Journal of the College of Physicians and Surgeons Pakistan JCPSP	106
37.	Reproductive Health	102
38.	Journal of Photochemistry and Photobiology B. Biology	94
39.	Analytical Letters	88
40.	BMJ Open	87
41.	Frontiers in Pharmacology	87
42.	American Journal of Human Genetics	86

S#	Source Title	NoP*
43.	Journal of Asian Natural Products Research	86
44.	International Journal of Environmental Analytical Chemistry	84
45.	Journal of Medicinal Plants Research	83
46.	Natural Product Communications	80
47.	Pharmaceutical Biology	80
48.	Journal of Radioanalytical And Nuclear Chemistry Articles	78
49.	Lipids in Health And Disease	76
50.	Cochrane Database of Systematic Reviews	75

*NoP: Number of Publications.

publications. They are the U.S. Department of Health and Human Services (n=63), National Institutes of Health (n-61), National Institute of Allergy and Infectious Diseases (N=18), United States Agency for International Development (n=12), International Atomic Energy Agency (N=11), and U.S. Department of Health, Education and Welfare (N=10).

After 2001, the trend in financial sponsorship and grants dramatically increased. National Institutes of Health and the U.S. Department of Health and Human Services have financially acknowledged in more than one thousand (n=1000) publications. Some other worthy donors are the National Natural Science Foundation of China (n=408), National Natural Science Foundation of China (n=408), UK Research and Innovation (n=375), Medical Research Council (n=328), Bill and Melinda Gates Foundation (n=310), Fogarty International Center (N=257), Eunice Kennedy Shriver National Institute of Child Health and Human Development (n=207), European Commission (n=197), Wellcome Trust (n=184), Alabama Commission on Higher Education (N=166), King Saud University N=163), Ministry of Science and Technology of the People's Republic of China (N=143), National Institute on Deafness and Other Communication Disorders (n=135), National Heart, Lung, and Blood Institute (n=120), Deanship of Scientific Research, King Saud University (N=118), World Health Organization (n=113), National Institute for Health Research (N=105), Ministry of Education of the People's Republic of China (N=101) and Government of Canada (n=100), to name a few.

Furthermore, thirty (n=30) national and global sponsors are acknowledged in fifty to ninety-nine (50 to 99) publications. Last but not the least, seventy-four (n=74) organizations have been acknowledged in twenty to forty-nine publications. In table 4, the list of the top 50 funding sources is described for both eras (1947 to 2000 and from 2001 to 2020).

There is no doubt that national and international collaboration plays a pivotal role in research development. It can enable the researchers to access additional infrastructure, laboratory facilities, and gain new perspectives in research. It may involve bilateral and multilateral relationships and collaborations in different fields of science. It has an integral place in the careers of researchers.

In Pakistan, from 1947 to 2000 the international collaboration was very low. From 1947 to 2000, eighty-fours (n=84) countries affiliations are noticed in publications. The highest collaboration in publications was noted with United States (n=274), followed by United Kingdom (n=216), Sweden (N=50), Germany (n=38), Japan (N=32), Switzerland (n=30), China (n=27), India (N=23), Netherlands (n=22), Thailand (N=22), and Turkey (n-22). Ten countries were noticed in ten to twenty publications (10 to 20), while 63 countries collaborated in less than nine (n=9) publications.

From 2001-onwards the collaboration completely changed. One hundred and forty-eight countries' affiliations were noted in at least ten publications. The top ten countries in this list are United States (n=3962), United Kingdom (n=2557), China (N=1793), Saudi Arabia (N=1736), Canada (N=1311), India (N=1228), Germany (N=892), Australia (n=880), Malaysia (N=874), and Switzerland (n=589).

In Table 5, the list of the top 50 collaborating

Table 4. The list of top 50 funding sponsors for both eras.

S#	From 1947 to 2000	NoP*	S#	From 2001 to 2020	NoP*
1.	U.S. Department of Health and Human Services	63	1.	National Institutes of Health	1062
2.	National Institutes of Health	61	2.	U.S. Department of Health and Human Services	1050
3.	National Institute of Allergy and Infectious Diseases	18	3.	Higher Education Commission, Pakistan	615
4.	United States Agency for International Development	12	4.	National Natural Science Foundation of China	408
5.	International Atomic Energy Agency	11	5.	UK Research and Innovation	375
6.	U.S. Department of Health, Education and Welfare	10	6.	Higher Education Commision, Pakistan	345
7.	World Health Organization	9	7.	Medical Research Council	328
8.	U.S. Public Health Service	8	8.	Bill and Melinda Gates Foundation	310
9.	Medicinska Forskningsrådet	6	9.	Fogarty International Center	257
10.	National Cancer Institute	6	10.	Eunice Kennedy Shriver National Institute of Child Health and Human Development	207
11.	National Institute of Neurological Disorders and Stroke	6	11.	European Commission	197
12.	U.S. Department of State	6	12.	Wellcome Trust	184
13.	UK Research and Innovation	5	13.	Alabama Commission on Higher Education	166
14.	European Commission	4	14.	King Saud University	163
15.	Medical Research Council	4	15.	Ministry of Science and Technology of the People's Republic of China	143
16.	U.S. Department of Defense	4	16.	National Institute on Deafness and Other Communication Disorders	135
17.	Center for Communicable Disease Dynamics	3	17.	National Heart, Lung, and Blood Institute	120
18.	Department for International Development, UK Government	3	18.	Deanship of Scientific Research, King Saud University	118
19.	Harvard T.H. Chan School of Public Health	3	19.	World Health Organization	113
20.	Pakistan Science Foundation	3	20.	National Institute for Health Research	105
21.	United Nations High Commissioner for Refugees	3	21.	Ministry of Education of the People's Republic of China	101
22.	Wellcome Trust	3	22.	Government of Canada	100
23.	Bangladesh Council of Scientific and Industrial Research	2	23.	Canadian Institutes of Health Research	93
24.	British Heart Foundation	2	24.	National Human Genome Research Institute	89
25.	Engineer Research and Development Center	2	25.	Ministry of Education, Culture, Sports, Science and Technology	88
26.	Epilepsy Foundation	2	26.	National Institute of Allergy and Infectious Diseases	86
27.	International Research Office	2	27.	Seventh Framework Programme	86
28.	Karolinska Institutet	2	28.	National Institute of Diabetes and Digestive and Kidney Diseases	84
29.	National Academies of Sciences, Engineering, and Medicine	2	29.	GlaxoSmithKline	82
30.	National Academy of Sciences	2	30.	Deutsche Forschungsgemeinschaft	80
31.	National Heart, Lung, and Blood Institute	2	31.	National Health and Medical Research Council	79

S#	From 1947 to 2000	NoP*	S#	From 2001 to 2020	NoP*
32.	National Institute of Arthritis and Musculoskeletal and Skin Diseases	2	32.	Sanofi	77
33.	National Institute of Diabetes and Digestive and Kidney Diseases	2	33.	Department of Health, Australian Government	76
34.	Scottish Office Home and Health Department	2	34.	National Cancer Institute	75
35.	U.S. Army	2	35.	Fundamental Research Funds for the Central Universities	74
36.	U.S. Army Corps of Engineers	2	36.	Ministry of Finance	72
37.	U.S. Navy	2	37.	National Research Foundation of Korea	70
38.	United Nations	2	38.	Pfizer	69
39.	United Nations Development Programme	2	39.	United States Agency for International Development	69
40.	Universiteit Utrecht	2	40.	Japan Society for the Promotion of Science	68
41.	University of Maryland	2	41.	National Eye Institute	67
42.	University of Maryland School of Public Health	2	42.	National Key Research and Development Program of China	67
43.	Yorkshire Cancer Research	2	43.	Pakistan Science Foundation	66
44.	Alexander von Humboldt-Stiftung	1	44.	Boehringer Ingelheim	63
45.	Atomic Energy Council	1	45.	National Institute of General Medical Sciences	63
46.	Biotechnology and Biological Sciences Research Council	1	46.	Novartis	63
47.	British Dietetic Association	1	47.	National Institute of Mental Health	61
48.	Canadian International Development Agency	1	48.	Quaid-i-Azam University	59
49.	Chinese Arctic and Antarctic Administration	1	49.	National Institute on Aging	56
50.	Chinese Center for Disease Control and Prevention	1	50.	AstraZeneca	54

*NoP: Number of Publications.

Table 5. The list of top 50 collaborating countries for both eras.

S#	From 1947 to 2000	NoP*	S#	From 2001 to 2020	NoP*
1.	United States	274	1.	United States	3962
2.	United Kingdom	216	2.	United Kingdom	2557
3.	Sweden	50	3.	China	1793
4.	Germany	38	4.	Saudi Arabia	1736
5.	Japan	32	5.	Canada	1311
6.	Switzerland	30	6.	India	1228
7.	China	27	7.	Germany	892
8.	India	23	8.	Australia	880
9.	Netherlands	22	9.	Malaysia	874
10.	Thailand	22	10.	Switzerland	589
11.	Turkey	22	11.	Italy	581
12.	Australia	19	12.	South Korea	558
13.	Singapore	19	13.	South Africa	549
14.	Saudi Arabia	18	14.	Bangladesh	544
15.	Canada	17	15.	Sweden	522
16.	Italy	17	16.	Turkey	515
17.	France	16	17.	France	511
18.	Egypt	15	18.	Brazil	510
19.	Brazil	14	19.	Egypt	487
20.	Austria	12	20.	Iran	478

S#	From 1947 to 2000	NoP*	S#	From 2001 to 2020	NoP*
21.	Philippines	10	21.	Netherlands	474
22.	Denmark	9	22.	Japan	471
23.	South Africa	9	23.	Spain	383
24.	Bangladesh	8	24.	United Arab Emirates	380
25.	Indonesia	8	25.	Singapore	334
26.	Mexico	8	26.	Thailand	326
27.	Russian Federation	8	27.	Nigeria	324
28.	United Arab Emirates	8	28.	Kenya	299
29.	Poland	7	29.	Austria	290
30.	Zambia	7	30.	Belgium	290
31.	Chile	6	31.	Norway	273
32.	Colombia	6	32.	Philippines	270
33.	Cuba	6	33.	Denmark	267
34.	Jamaica	6	34.	Argentina	266
35.	Jordan	6	35.	Nepal	260
36.	Belgium	5	36.	Poland	255
37.	Kenya	5	37.	New Zealand	252
38.	Tunisia	5	38.	Indonesia	248
39.	Finland	4	39.	Mexico	247
40.	Greece	4	40.	Colombia	238
41.	Hong Kong	4	41.	Oman	236
42.	Hungary	4	42.	Taiwan	235
43.	Kuwait	4	43.	Finland	231
44.	Malaysia	4	44.	Vietnam	230
45.	Nigeria	4	45.	Hong Kong	217
46.	Spain	4	46.	Sri Lanka	217
47.	Sri Lanka	4	47.	Ireland	199
48.	Czech Republic	3	48.	Russian Federation	198
49.	Guatemala	3	49.	Peru	192
50.	Ireland	3	50.	Chile	191

*NoP: Number of Publications.

countries is described for both eras (1947 to 2000 and from 2001 to 2020).

4. LIMITATIONS

The major limitation is, we only analyzed the Scopus data. Other databases were not explored.

5. ACKNOWLEDGEMENTS

The hard work of all authors, institutes, funding and collaborative countries in all research publications is sincerely appreciated.

6. CONFLICT OF INTEREST

There is no conflict of interest.

7. FUNDING

The author received no financial support for this article.

8. REFERENCES

1. E.S. Kim, D.Y. Yoon, H.J. Kim, K. Lee, Y. Kim, J. S. Bae, and J.H. Lee. The most mentioned neuroimaging articles in online media: a bibliometric analysis of the top 100 articles with the highest Altmetric Attention Scores. *Acta Radiologica* 0(0): 1-7 (2019).
2. J.L. Fan, S. Shen, J.D. Wang, S.J. Wei, X. Zhang, P. Zhong, and H. Wang. Scientific and technological power and international cooperation in the field of natural hazards: a bibliometric analysis. *Natural Hazards* 102, 807-827 (2020).
3. S.H. Zyoud, W.S. Waring, S.W. Al-Jabi, and W.M. Sweileh. Global cocaine intoxication research trends during 1975-2015: a bibliometric analysis of Web of Science publications. *Substance Abuse Treatment, Prevention, and Policy* 12: 1-6 (2017).
4. V. Nafade, M. Nash, S. Huddart, T. Pande, N. Gebreselassie, C. Lienhardt, and M. Pai. A bibliometric analysis of tuberculosis research,

2007–2016. *PloS one,* 13(6), e0199706 (2018).
5. L.M. Weng, Y.L. Zheng, M.S. Peng, T.T. Chang, B. Wu, and X.Q. Wang. A bibliometric analysis of nonspecific low back pain research. *Pain Research and Management* 1-13 (2020).
6. W.M. Sweileh. Bibliometric analysis of medicine-related publications on refugees, asylum-seekers, and internally displaced people: 2000 – 2015. *BMC International Health and Human Rights* 17: 1- 11 (2017)
7. A. Odone, S. Salvati , L.Bellini , D. Bucci, M. Capraro, G. Gaetti, A. Amerio, C. Signorelli. The runaway science: a bibliometric analysis of the COVID-19 scientific literature. Acta Biomed 91(9S): 34-39 (2020).
8. E. Demir, and A. Comba. The evolution of celiac disease publications: a holistic approach with bibliometric analysis. *Ir J Med Sci* 189: 267–276 (2020).
9. N.A. Primo, V.B. Gazzola, B.T. Primo, M.F. Tovo, and I.M. Faraco Junior. Bibliometric analysis of scientific articles published in Brazilian and international orthodontic journals over a 10-year period. *Dental Press Journal of Orthodontics* 19: 56–65 (2014).
10. M. Soosaraei, A.A. Khasseh, M. Fakhar, and H.Z. Hezarjaribi. A decade bibliometric analysis of global research on leishmaniasis in Web of Science database. *Annals of medicine and Surgery* 26, 30-37 (2018).
11. C.A. Bonilla, J.M. Merigó, and C. Torres-Abad. Economics in Latin America: a bibliometric analysis. *Scientometrics* 105, 1239–1252 (2015).
12. B. Elango. A bibliometric analysis of literature on engineering research among BRIC countries. *Collection and Curation* 38: 34-39 (2019).
13. J.A. Moral-Munoz, L. Carballo-Costa, E. Herrera-Viedma, and M.J. Cobo. Production trends, collaboration, and main topics of the integrative and complementary oncology research area: a bibliometric analysis. *Integrative cancer therapies* 18, 1534735419846401 (2019).
14. M. Kocak, C. García-Zorita, S. Marugán-Lázaro et al. Mapping and clustering analysis on neuroscience literature in Turkey: a bibliometric analysis from 2000 to 2017. *Scientometrics* 121, 1339–1366 (2019).
15. A. Özkaya. Bibliometric Analysis of the Studies in the Field of Mathematics Education. *Educational Research and Reviews* 13(22): 723-734 (2018).
16. Ü. Muslu. The Evolution of Breast Reduction Publications: A Bibliometric Analysis. *Aesthetic Plastic Surgery* 42: 679–691 (2018).
17. E. Demir, E. Yaşar, V. Özkoçak, & E. Yıldırım. The evolution of the field of legal medicine: A holistic investigation of global outputs with bibliometric analysis. *Journal of Forensic and Legal Medicine* 69: 101885 (2020).
18. M. Kiraz, and E. Demir. A Bibliometric analysis of publications on Spinal Cord injury during 1980–2018. World Neurosurgery 136, e504-e513 (2020).
19. R. S. Bajwa and K. Yaldram. Bibliometric analysis of biotechnology research in Pakistan. *Scientometrics* 95:529–540 (2013).
20. N. Siddique, S. Rehman, M.A.Khan, and A. Altaf. Library and information science research in Pakistan: *A bibliometric analysis,* 1957–2018. *Journal of Librarianship and Information Science* 53:89-102 (2020).
21. I.Ul. Haq. Social Sciences Research in Pakistan; Bibliometric Analysis. *Library Philosophy and Practice (e-journal)*. 4499 (2020).
22. A. Faiz. Bibliometric analysis of computer science literature of Pakistan. *Global Scientific Journal* 8: 3728-48 (2020).
23. J. Mace, and H.K. Niazi. The Contribution of the Private Sector to Higher Education in Pakistan with Particular Reference to Efficiency and Equity. *Bulletin of Education & Research* 28: 17–42 (2006).
24. A. Isani, and U. Ali. Higher Education in Pakistan. *National University of Modern Languages:* 378 (2001).
25. A. Isani, and U.Ali. Education Policy, 1972-80. 40-74 (2013).