Mapping the Health and Medical Research Excellence in Nepal: A Study of High-Cited Papers During 1994-2023

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ABSTRACT

Background: A bibliometric analysis was performed to map the current status and development trends in medical research in Nepal. It aims to visualize research hotspots within this field and provide effective guidance for future research directions.

Methods: A systematic search of the Scopus database was performed to identify high-cited papers (HCPs) on medical research in Nepal between January 1, 1994, and December 31, 2023. Bibliometrics techniques were applied to analyze the publication dates, countries, institutions, journals, authors, and research hotspots. Statistical analysis and visualization were carried output by MS-Excel and VOSviewer software.

Results: A total of 326 HCPs were identified that have received 100 to 10719 citations and registered 223.05 Citations Per Paper (CPP). The 47.54% and 95.40% share of the 326 HCPs have received external funding support and are involved in international collaboration, respectively. The 15892 (417 from Nepal) authors, affiliated to 12830 (177 from Nepal) organizations and published in 138 journals participated in 326 HCPs from Nepal. USA (60.45% share) and India. (51.45% share) were the most collaborative countries, while Spain (1609.15 CPP) and Mexico (1597.08 CPP) made the largest citation impact in collaboration with Nepal. C.L. Ranabhat (n=27) and B. Sathian (n=26) were the most productive authors, while D. Acharya (3652.29 and 16.5), and S. Bhattarai (2880.11 and 13.01) registered the highest citation impact (CPP and RCI). Tribhuvan University, Kathmandu (n=72) and Nepal Health Research Council, Kathmandu (n=34) were the most productive organizations, while Kathmandu University (3652.29 and 16.5) and Nepal Academy of Science and Technology, Lalitpur (2941.67 and 13.29) registered the highest citation impact (CPP and RCI). *The Lancet* (n=75) and *British Medical Journal* (n=11) were the most productive journals, while *The Lancet Neurology* (1749.5 CPP), and *The Lancet* (1371.13 CPP) registered the highest average citations impact. B. Basnyat has the most citation as first author in health and medical research.

Conclusions: The present study offers an overview of research characteristics and trends of medical research output in Nepal. It identifies main contributors, core journals, and significant subject topics. The study hopes to assist researchers and practitioners in comprehending the development and trends of medical research in Nepal and discovering potential directions for future research.

Keywords: Bibliometric methods; citations; collaboration; high-cited papers; medical research.

INTRODUCTION

Nepal is undergoing a rapid demographic transition with an aging population and declining fertility rates.[1] This shift, coupled with the dual burden of infectious and non-communicable diseases (NCDs), poses significant challenges to the health sector.[2-7] The National Health Policy (2019) aims to achieve Universal Health Coverage and prioritize vulnerable groups while promoting a

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balanced approach to healthcare.[3] Despite progress in key health indicators, Nepal's low research capacity hinders evidence-based policymaking.[8]

Medical research is crucial for addressing Nepal's complex health landscape. By examining high-cited medical publications involving Nepalese researchers and institutions, this study seeks to understand research trends, collaborations, and strengths. This knowledge will inform policymakers in enhancing medical research capacity and addressing critical health challenges.

The findings of this study will provide valuable insights into Nepal's research ecosystem, identify priority areas, and guide future research investments. Strengthening medical research is essential for improving the well-being of the Nepalese population.

METHODS

For collecting relevant literature, a search strategy (shown below) was conducted with the phrase 'Nepal' in the country address field and restricted to the Scopus subject category "medicine" on April 4, 2024, in the Scopus database. We chose the Scopus since it is considered one of the best databases for bibliometric studies because of its comprehensiveness, and broader coverage than any other database. In addition, it offers more accurate and comprehensive author profiles and institutional affiliations through a combination of advanced algorithms and manual curation, which is crucial for studies focusing on authorship trends or collaborations. Furthermore, Scopus is credited with having better tracking of citations across a wider range of publications, including conference proceedings, which can be valuable for specific fields.

The search yielded 16351 records (out of 31,734 records on Nepal) on medical research from Nepal during 1994-2023. These 16351 records were rearranged in decreasing order of citations, leading to the identification of 326 papers receiving 100 or more citations (considered here as high-cited papers). The 326 HCPs' bibliographic records were downloaded for detailed analysis to meet the objectives of the present study. For each record, the information on first and all country, institution, Nepalese author, author affiliation, funding and journal was downloaded and analysed. In this context, the role of the foreign and national first country, institution and authors becomes important which mainly facilitates Nepal's participation in international collaborative research. To visualize the collaborative relationship among key actors and identify the research hotspots

through keyword co-occurrence analysis, we have used VOSviwer and MS Excel software.

The most productive authors and organizations were considered as those who had the maximum number of publications, whereas the most impactful authors and organizations were those with the highest impact in terms of CPP and RCI.

The following search strategy was used: AFFILCOUNTRY (nepal) AND PUBYEAR > 1993 AND PUBYEAR < 2024 AND (LIMIT-TO (SUBJAREA , "MEDI"))

RESULTS

The high-cited papers (HCPs) from Nepal constituted 326 papers registering 100 to 8350 citations during 1994-2023. These papers showed high growth initially, increasing from 39 papers during 1994-2003 to 112 papers during 2004-13 and then witnessed slowed growth to 175 publications during 2014-2023. The annual growth of HCPs showed fluctuating growth till 2020 and then decline till 2023, with maximum output 24 and 46 reported in 2018 and 2020 **(Figure 1)**. The ten-year cumulative growth showed growth from 39 papers during 1994-23 to 112 papers during 2004-13 to 175 papers during 2014-23.

The 326 HCPs on medical research from Nepal together received 72175 citations, averaging 223.05 citations per paper (CPP). **[Supplementary Table 1]**. The citations received by 326 HCPs showed uneven distribution: 197 and 72 papers received 100-200 and 201-500 citations, against 22 and 4 papers received 501-1000 and more than 1000 citations.

By document type, articles (260, 79.75%) constitute the largest group among 326 HCPs, followed by reviews (48, 14.72%), letters (7, 2.15%), editorial and notes (4, 1.23% each), conference papers (2, 0.61%0 and short survey (1, 0.31).

By analyzing the geographical focus in medical research by Nepal, 126 out of 326 HCPs had focused on medical research problems of Nepal, followed by medical problems from developing countries (n=46), Asia (n=26), India (n=23), South Asia (n=20), China (n=21), Bangladesh (n=13) and Pakistan (n=8).

By examining 326 HCPs by research type, clinical studies (n=141) account for the highest number of papers, followed by epidemiology (n=106), risk factors (n=63), pathophysiology (n=21), treatment outcome (n=20),

complications (n=15), genetics and quality of life (n=10 each) and prognosis (n=8).

Among 326 HCPs, the largest focus (n=97) was reported on controlled studies by research design, followed by clinical trials and randomized controlled trials (n=39 each), controlled clinical trials (n=24), cross-sectional studies (n=22), comparative studies (n=21), prospective studies (n=20), retrospective studies (n=9), observational studies (n=8), and case reports (n=4).

By population age group focus, the largest number of studies (n=148) were reported on adults, followed by children & adolescents (n=127), aged (n=67) and middle-aged (n=65).
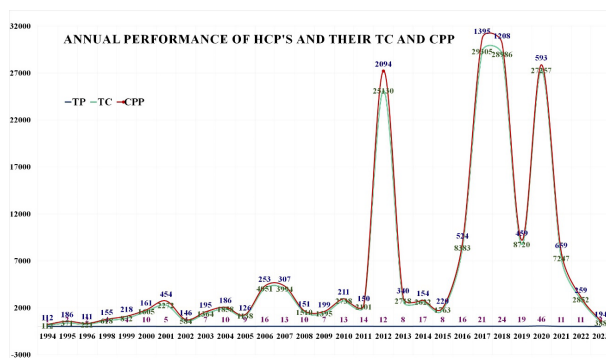

Figure 1. Annual performance of high-cited papers in medical research from Nepal during 1994-2023, showing the trends of total publications (TP), total citations (TC), and citations per paper (CPP).

International Funding

The 155 (47.54%) HCPs out of 326 received external funding support from more than 150 external international agencies and together received 137505 citations, averaging 887.13 CPP. Bill and Melinda Gates Foundation supported research contributed the largest number of funded papers (n=59), followed by the National Institutes of Health (n=55), National Health and Medical Research Council (n=37), Medical Research Council (n=35), Welcome Trust (n=33), Bundesministerium für Bildung und Forschung, European Commission and National Institute of Mental Health (n=26 each), etc.

International Collaboration

The 311 (95. 40%) HCPs out of 326 HCPs were involved in international collaboration with 160 foreign countries and together received 170133 citations, averaging 547.05 CPP.

Most Productive Foreign Countries

Among 160 foreign countries participated in 311 international collaborative papers (ICPs) out of 326 HCPs of Nepal. The USA contributed the largest share (60.45%) in the ICPs of Nepal, followed by India (51.45%), the U.K. (47.91%), Australia (34.41%), China (33.44%), Pakistan (30.87%), South Africa (30.55%), Canada (28.62%), Japan (28.30%), Brazil (27.97%), Germany (27.97%), Saudi Arabia (24.76%), Sweden (24.44%), Mexico (24.12%), Italy (24.12%), Spain (23.47%), Malaysia(23.47%), Nigeria (23.15%) and Iran (22.83%). In contrast, Spain registered the highest CPP of 1609.15 among top foreign countries followed by Mexico (1597.08 CPP), Sweden (1513.8 CPP), Italy (1509.64 CPP), Saudi Arabia (1470.69 CPP), Iran (1430.89 CPP), Nigeria (1415.06 CPP), Canada (1359.34 CPP), South Africa (1284.2 CPP), Japan (1267.69 CPP), Brazil (1238.56 CPP) and Malaysia (1226.81 CPP). The collaboration network map of the top 20 foreign collaborative countries with Nepal is depicted in **Figure 2.**
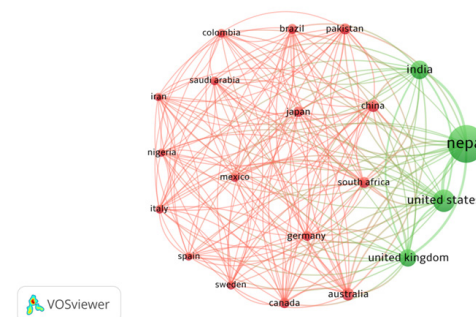

Figure 2. Network Collaboration Map of the top 20 foreign countries with Nepal Most Productive Foreign Organizations

Supplementary Table 2 lists the top 26 foreign organizations most actively collaborating with Nepal in medical research. They individually contributed 53 to 82 papers per organization and together contributed 1593 papers and 2446418 citations, accounting for more than 100% share each in Nepal's total papers and citations. **Table 1** lists the top five most productive and top five most impactful foreign organizations collaborating with Nepal.

S.No.	Affiliation of the foreign organizations	TP	TC	CPP
Table 1. Profile of the top five most Productive and top five Impactful Foreign Organizations collaborating with Nepal.				
Top 5 Most Productive Foreign Organizations				
1	London School of Hygiene & Tropical Medicine	82	116242	1417.59
2	Johns Hopkins University	72	100937	1401.90
3	University of Washington	71	98320	1384.79
4	University College London	68	88576	1302.59
5	National Institutes of Health NIH	65	99855	1536.23
Top 5 Most Impactful Foreign Organizations				
1	South African Medical Research Council	57	108519	1903.84
2	The University of Queensland, Australia	53	98077	1850.51
3	Monash University, Australia	53	98077	1850.51
4	University of New South Wales (UNSW), Sydney, Australia	57	103617	1817.84
5	University of Sydney, Australia	54	97815	1811.39

TP-Total Papers, TC-Total Citations, CPP-Citations Per Paper

Most Productive Collaborating Foreign Authors

Supplementary Table 3 lists the top 20 foreign authors most actively collaborating with Nepal in medical research. They individually contributed 42 to 51 papers and together contributed 897 papers and 1322506 citations, accounting for more than 100.0% share each in Nepal's total papers and citations. **Table 2** lists the top 5 most productive and top 5 most impactful foreign authors collaborating with Nepal.

S. No.	Name of the author	Affiliation of the author	TP	TC	CPP
Table 2. Profile of the top five most productive and top five impactful Foreign authors collaborating with Nepal.					
Top 5 Most Productive Foreign Authors					
1	Malekzadeh, R.	Tehran University of Medical Sciences, Digestive Disease Research Institute, Tehran, Iran.	51	92888	1821.33
2	Yonemoto, N.	Juntendo University Graduate School of Medicine, Tokyo, Japan	50	73897	1477.94
3	Fischer, F.	Bielefeld University, Department of Public Health, Germany	49	75512	1541.06
4	Hay, S.I.	Institute for Health Metrics and Evaluation, Seattle, United States	48	73895	1539.48
5	Sepanlou, S.G.	Digestive Diseases Research Institute, Tehran, Iran	48	72271	1505.65
Top 5 Most Impactful Foreign Authors					
1	Farzadfar, F.	Tehran University of Medical Sciences, Tehran, Iran	44	85595	1945.34
2	Naghavi, M.	Institute for Health Metrics and Evaluation, Seattle, United States	42	77049	1834.5
3	Malekzadeh, R.	Tehran University of Medical Sciences, Digestive Disease Research Institute, Tehran, Iran.	51	92888	1821.33
4	Majeed, A.	Imperial College London, United Kingdom	42	72938	1736.62
5	Khader, Y.S.	Jordan University of Science and Technology, Irbid, Jordan	44	74874	1701.68

TP=Total papers; TC=Total citations; CPP=Citations per paper

Leading Nepal Organizations

A total of 12830 organizations (177 from Nepal) participated in 326 HCPs from Nepal in medical research. The top 30 Nepal organizations individually published 5 to 72 papers and together published 386 papers and 422971, accounting for more than 100% share each in total HCP papers and citations. **Supplementary Table 4** presents the publication profile of the top 30 organizations contributing 5 or more papers. On further analysis, it was observed that (i) eight Nepal organizations contributed more than the average productivity (12.87) of all 30 organizations and (ii) 15 Nepal organizations registered CPP and RCI more than their average (1095.78 and 4.95). **Table 3** presents the publication profile of the top 8 most productive and 8 most impactful organizations.

S. No.	Organization	TP	TC	CPP	RCI	TLS
Table 3. Top 8 most Productive and 8 most Impactful Nepal organizations participating in 326 High Cited Papers.						
Top 8 Most Productive Nepal Organizations						
1	Tribhuvan University, Kathmandu	72	48608	675.11	3.05	113
2	B.P. Koirala Institute Of Health Sciences, Dharan	31	40074	1292.71	5.84	9
3	Nepal Health Research Council, Kathmandu	34	43394	1276.29	5.76	112
4	Nepal Development Society, Pokhara	22	37289	1694.95	7.66	33
5	Kathmandu University	18	27067	1503.72	6.79	11
6	Nepal Nutrition Intervention Project-Sarlahi, Nepal	17	2961	174.18	0.79	5
7	Policy Research Institute, Kathmandu	15	17531	1168.73	5.28	64
8	Abt Associates Nepal, Patan, Kathmandu	14	32090	2292.14	10.35	79
Top 8 Most Impactful Nepal Organizations						
1	Kathmandu University	7	25566	3652.29	16.50	35
2	Nepal Academy of Science and Technology, Lalitpur	6	17650	2941.67	13.29	40
3	Abt Associates Nepal, Patan	14	32090	2292.14	10.35	79
4	Health Science Foundation and Study Center, Kathmandu	6	12509	2084.83	9.42	16
5	Far Western University, Mahendranagar	7	13450	1921.43	8.68	40
6	Save The Children, Health, Nutrition, And HIV/Aids Program, Kathmandu	9	17174	1908.22	8.62	64
7	Global Institute For Interdisciplinary Studies, Kathmandu	5	9236	1847.2	8.34	20
8	Nepal Development Society, Pokhara	22	37289	1694.95	7.66	33
TP=Total papers; TC=Total citations; CPP=Citations per paper; RCI: Relative citation index; TLS: Total link strength						

In terms of link strength, the maximum (113 TLS) collaborative strength is depicted by Tribhuvan University, Kathmandu, followed by Nepal Health Research Council, Kathmandu (n=112), Abt Associates Nepal, Patan (n=79), Policy Research Institute, Kathmandu and Save The Children, Health, Nutrition, And HIV/Aids Program, Kathmandu (n=64 each), Ipas Nepal, Monitoring, And Evaluation Kathmandu (n=56), etc. The collaboration was studied and visualized among the top 30 organizations, with 5 or more documents, using VOSviewer software **(Figure 3).** The software divided the top 30 organizations into 14 clusters with 68 links followed by 251 TLS as shown in Figure 2. Clusters 1 and 2 have 5 organizations each, Clusters 3 and 4 with 4 organizations each, cluster 5 with 3 organizations and other remaining clusters from 6-14 one organization respectively.
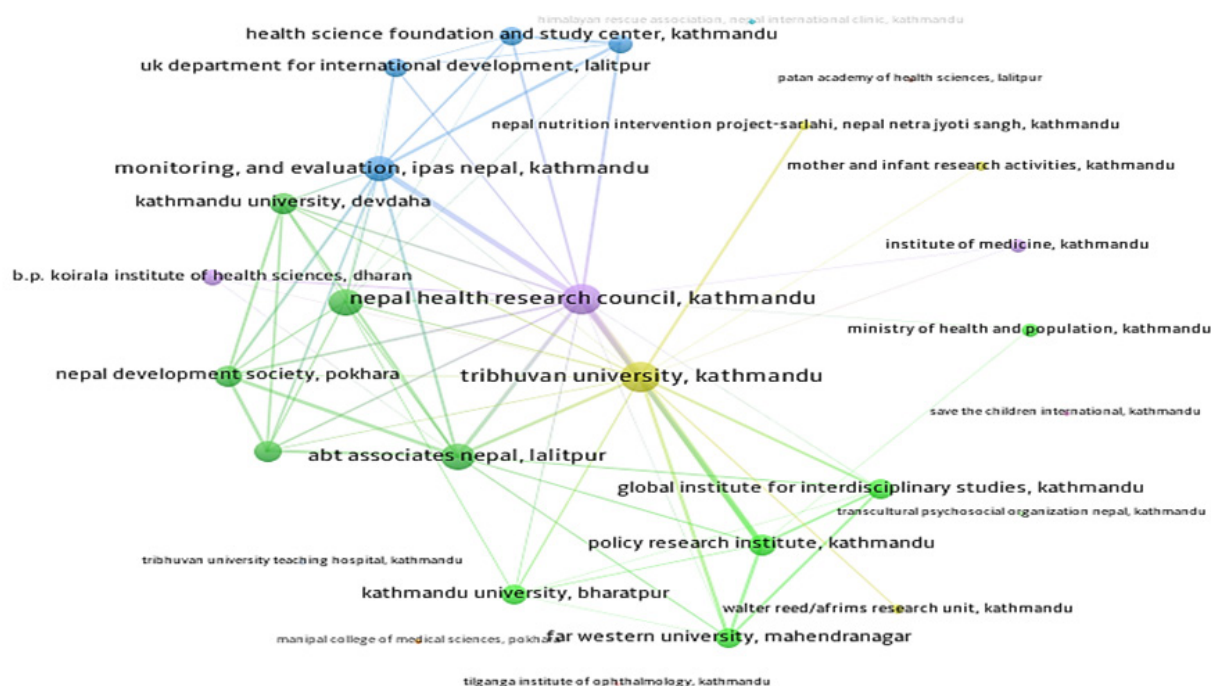
Figure 3. Collaborative Network Visualization Map among Top 30 Nepal Organizations.

Leading Nepal's Authors

A total of 15892 authors (417 from Nepal) participated in 326 HCPs from Nepal in medical research. The top 30 Nepal authors individually published 5 to 27 papers and together published 321 papers and 399951 citations, accounting for more than 100% share each in total HCP papers and citations. **Supplementary Table 5** presents the publication profile of the top 30 Nepal authors contributing 5 or more papers. On further analysis, it was observed that : (i) Ten Nepal authors contributed more than the average productivity (10.73) of all 31 authors. Fifteen Nepal authors registered CPP and RCI more than their average (1245.95 and 5.63) of all 31 authors: **Table 4** presents the publication profile of the top 8 most productive and 8 most impactful authors.

S.No.	Author	Affiliations	TP	TC	CPP	RCI	TLS
Table 4. Top 8 most Productive and top 8 most impactful Nepal authors participating in 326 High Cited Papers.							
Top 8 most productive authors							
1	Ranabhat C.L.	Health Science Foundation and Study Center, Kathmandu	27	43014	1593.11	7.20	116
2	Sathian B.	Manipal College of Medical Sciences, Department of Community Medicine, Pokhara, Nepal	26	42146	1621.00	7.32	128
3	Aryal K.K.	Nepal Health Research Council, Kathmandu	24	52487	2186.96	9.88	112
4	Khatry S.K.	Nepal Nutrition Intervention Project-Sarlahi, Nepal Netra Jyoti Sangh, Kathmandu	18	3087	171.50	0.77	16
5	Dhimal M.	Nepal Health Research Council, Kathmandu	17	17192	1011.29	4.57	83
6	Mehata S.	Nepal Public Health Founda, Kathmandu	16	28362	1772.63	8.01	74
7	Rijal S.	B.P. Koirala Institute of Health Sciences, Dharan	14	3267	233.36	1.05	5

S.No.	Author	Affiliations	TP	TC	CPP	RCI	TLS
8	Paudel D.	Health, Nutrition, and HIV/AIDS Program, Save the Children, Kathmandu	13	20203	1554.08	7.02	90
Top 8 most impactful authors							
1	Acharya D.	Kathmandu University	7	25566	3652.29	16.50	40
2	Bhattarai S.	Global Institute for Interdisciplinary Studies, Kathmandu	9	25921	2880.11	13.01	87
3	Aryal K.K.	Nepal Health Research Council, Kathmandu	24	52487	2186.96	9.88	112
4	Mahotra N.B.	Tribhuvan University, Kathmandu	7	13652	1950.29	8.81	33
5	Bhandari D.	Nepal Health Research Council, Kathmandu	7	13592	1941.71	8.77	43
6	Dhungana G.P.	Far Western University, Mahendranagar	7	13450	1921.43	8.68	39
7	Deuba K.	National Center of AIDS & STD Control, Global Fund Program, Kathmandu	5	9150	1830.00	8.27	30
8	Mehata S.	Nepal Public Health Founda, Kathmandu	16	28362	1772.63	8.01	74
TP=Total papers; TC=Total citations; CPP=Citations per paper; RCI: Relative citation index; TLS: Total link strength							

Table 4. Top 8 most Productive and top 8 most impactful Nepal authors participating in 326 High Cited Papers.

In terms of link strength, the maximum (19 TLS) collaborative strength is depicted by B. Sathian, followed by C.L. Ranabhat (n=18), K.K. Aryal (n=17), P. Acharya (n=16), S. Bhattarai and M. Dhimal M (n=15 each), S. Mehata and A. Pandey (N=14 each), S.K. Sharma (n=13), T.B. Adhikar, A.Banstola, N.N. Mahotra and D. Acharya (n=12 each), D. Paudel and D. Bhandari (n=11 each), etc.. The collaboration was studied and visualized among the top 30 authors, with 5 or more documents, using VOSviewer software (**Figure 4**). The software divided the top 30 authors into 7 clusters with 140 links followed by 613 TLS as shown in Figure 3. Cluster 1 had 6 organizations, Clusters 2, 3 and 4 had 5 organizations each, and Clusters 5, 6 and 7 had 3 organizations each.
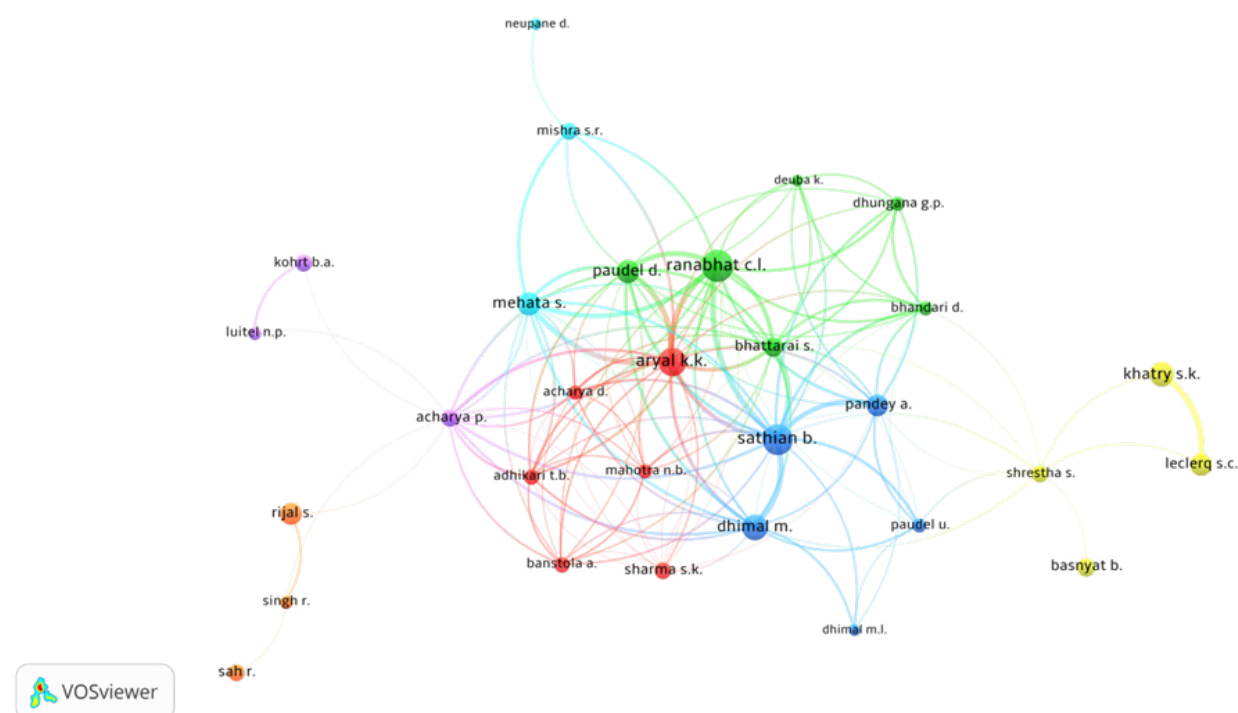

Figure 4.Collaborative Network Visualization Map among Top 30 Nepal Authors Top 10 Most Prolific Nepalese Authors as the First Authors

Table 5 presents an analysis of the top 10 most prolific Nepalese authors in health and medical research, ranked by their total number of HCPs as the first authors. B. Basnyat and G.P. Pokharel were the leading authors with 3 HCPs each, followed by S. Rijal, S.K. Sharma, and R.M.Kunwar with 2 HCPs each.

Sl. No.	Authors	Affiliation	TP	TC	CPP
Table 5. Top 10 Most Prolific Nepalese Authors as First Authors in Health and Medical Research.					
1	Basnyat B.	Patan Hospital, Himalayan Rescue Association, Kathmandu	3	638	212.67
2	Pokharel G.P.	Foundation Eye Care Himalaya, Kathmandu	3	554	184.67
3	Rijal S.	B.P. Koirala Institute of Health Sciences, Dharan	2	355	177.50
4	Sharma S.K.	B.P. Koirala Institute of Health Sciences, Dharan	2	266	133.00
5	Kunwar R.M.	Center for Biological Conservation, Kathmandu	2	249	124.50
6	Manandhar P.D.S.	Maternal and Infant Research Activities, Kathmandu	1	631	631.00
7	Shrestha M.P.	Walter Reed-Armed Forces Research Institute of Medical Sciences Research, Kathmandu	1	450	450.00
8	Gupta R.K.	National Medical College, Nepal	1	299	299.00
9	Shankar P.R.	Manipal College of Medical Sciences, Pokhara	1	252	252.00
10	Shrestha N.M.	Center for Victims of Torture, Kathmandu	1	234	234.00
TP=Total Publications; TC=Total Citations; CPP=Citation per Paper					

We have not included the non-Nepalese authors (Kohrt, Sreeramareddy, and van Ommeren) in this table, who have worked at some point of time in Nepal and published as the first author based on their study on Nepali population.

Leading Journals

The 362 HCPs on medical research from Nepal were published in 138 journals. The top 25 most productive journals individually published 3 to 75 papers and together contributed 192 papers and 49628, constituting 58.9% and 68.25% share respectively of Nepal's global output and citations. **Supplementary Table 6** presents the publication profile of the top 25 journals publishing 3 or more papers. The top 6 journals (i) by publication productivity were: *The Lancet* (n=75), *British Medical Journal* (n=11), *The Lancet Global Health* (n=10), *American Journal of Tropical Medicine and Hygiene* (n=9), *New England Journal Of Medicine* (n=8) and *JAMA* (n=6); (ii) by total citations were: *The Lancet* (n=10283), *New England Journal Of Medicine* (n=8025), *The Lancet Neurology* (n=6998), *The Lancet Global Health* (n=4225), *JAMA Oncology* (n=2593) and *Travel Medicine and Infectious Disease* (n=2172); (iii) by citation per paper were: *The Lancet Neurology* (1749.5 CPP), *The Lancet* (1371.13 CPP), *New England Journal Of Medicine* (1003.13 CPP), *JAMA Oncology* (864.33 CPP), *Travel Medicine and Infectious Disease* (434.4 CPP) and *The Lancet Global Health* (422.5 CPP); (iv) by impact factor of the journal were: The *Lancet* (n=75)(IF=168.9), *New England Journal Of Medicine* (n=8)(IF=158.5), *JAMA (*n=6)(IF=120.7), *British Medical Journal* (n=11)(IF=105.7), *The Lancet Infectious Diseases* (n=4)(IF=56.3) and *The Lancet Neurology* (n=4)(IF=48.0).

A co-citation analysis of the top 25 journals with 3 or more documents was carried out, using VOSviewer software **(Supplementary Figure 1).** The resulting co-citation network of these journals comprised 21 links with a total link strength of 45, forming 18 clusters.

Broad Subject Areas

Health research priority-setting practices assist researchers and policymakers in effectively pointing out research that has the greatest potential public health benefit. As per the classification provided by the policy document[9], we have classified the 326 HCPs from Nepal under 8 broad subject areas as shown in **Table 6**. Many document records are classified in more than one broad subject area. The largest number of papers (n=119) were contributed in the area of non-communicable diseases, followed by communicable/infectious diseases (n=97), maternal, new-born and child health including reproductive health (n=58), other areas (n=48), environment, climate change and occupational

health (15), nutrition and food safety (n=12) and accidents, injuries and violence (n=10). Except for other areas, the largest citation impact per paper is made by accidents, injuries and violence (3400.86 CPP), followed by environment, climate change and occupational health (701.33 CPP), non-communicable diseases (515.76 CPP), health systems (354.76 CPP), communicable/infectious diseases (236.89 CPP), maternal, new-born and child health including reproductive health (219.83 CPP) and nutrition and food safety (163.77)

Under non-communicable diseases, the major emphasis (n=23) was on emerging and re-emerging Infection (Covid-19), followed by neglected tropical diseases (like leprosy, dengue, visceral leishmaniasis (Kalazar) (n=21), tropical diseases (tuberculosis, malaria and Japanese encephalitis)(n=14), liver and hepatitis (n=12), bacterial/fungal infections (n=7), diarhoe (n=5), AIDS/HIV (n=4), eneric fever/typhoid (n=3), etc. Under non-communicable diseases, the major emphasis (n=31) was on psychiatric disorders, followed by cardiovascular Diseases (hypertension, stroke, ischemic heart disease, rheumatic/valvular diseases and blood pressure)(n=17), Eye/ENT diseases (n=16), neurological diseases (n=12), cancer (n=11), metabolic diseases (diabetes, obesity, etc)(n=7), respiratory/lung (n=5), haematological/blood (n=4), kidney/urinary (n=3), alcohol use (n=2), etc.

Table 6. Broad Subject Areas of Medical Research from Nepal as reflected in 326 HCPs from Nepal.

S. No	Broad Medical Subject Areas	TP*	TC	CPP
1	Health Systems	16	6031	354.76
2	Non-Communicable Diseases	119	61375	515.76
3	Communicable/ Infectious Diseases	97	22979	236.89
4	Maternal, New-born and Child Health including Reproductive Health	43	10424	242.43
5	Accidents, Injuries and Violence	10	19251	1925.1
6	Nutrition and Food Safety	12	2340	195.0
7	Environment, Climate Change and Occupational Health	15	12221	814.73
8	Other Areas			
	High Altitude Illness	8	1567	195.87

Table 6. Broad Subject Areas of Medical Research from Nepal as reflected in 326 HCPs from Nepal.

S. No	Broad Medical Subject Areas	TP*	TC	CPP
	Disease Burden - Mortality	8	21282	2660.25
	Disease Burden – Incidence	3	14108	4702.67
	Disease Burden – Prevalence	3	14108	4702.67
	Disease Burden – Disability	11	31925	2902.27
	Drugs	5	953	190.6
	Vaccine	2	258	129.0
	Medicinal plants	5	646	129.20
	Genomics	3	409	136.3
	Total	48	84303	1960.53
	All Combined	371		

TP=Total papers; TC=Total citations; CPP=Citations per paper

□ Many papers are classified under more than one subject category

TP=Total papers; TC=Total citations; CPP=Citations per paper

Keywords Analysis

By analyzing the keywords in HCPs, we can get a glimpse of research emphasis, the areas of interest of researchers and the developmental trends. A total of 4,366 keywords were identified from 326 HCPs, of which 215 keywords were selected for co-occurrence analysis, based on their collaborative links (ranging from 1 to 172) and total link strengths (ranging from 1 to 615) for further examination. The most significant keywords were: 'Prevalence' (n=66), 'risk factor' (n=61), 'global health' (n=59), 'global disease burden' (n=51), 'mortality' (n=50), 'incidence' (n=44), 'diarrhoea' (n=34), 'health survey' (n=32), 'Pregnancy' (n=28), and 'coronavirus disease 2019' (n=26).

The co-occurrence network analysis classified the 215 selected keywords into seven distinct clusters providing insights into subfields, their research impact and interconnectivity. These clusters collectively comprised a total of 1,052 links and 3,323 link strengths, as shown in **Supplementary Figure 2.**

Cluster 1 (Red): Keywords related to the 'prevalence'

(n=66), 'risk factors' (n=61), and 'burden of global diseases' (n=51), with occurrences ranging from 1 to 66, links ranging from 2 to 172, and total link strengths ranging from 4 to 615. Cluster 2 (Green): Keywords related to specific diseases and conditions such as 'visceral leishmaniasis' (n=19), 'diabetes mellitus' (n=17), and various types of cancer such as 'bronchus cancer', 'lung cancer', 'trachea cancer', and 'liver cancer' (n=7) each, with occurrences ranging from 2 to 19, links from 9 to 158, and total link strengths from 105 to 395. Cluster 3 (Blue): Keywords related to 'health care policy' (n=22), 'antibiotic resistance' (n=16), and 'mental health' (n=13) with occurrences ranging from 2 to 22, links from 5 to 134, and total link strengths from 6 to 229. Cluster 4 (Yellow): Keywords related to infectious diseases such as 'human immunodeficiency virus infection' (n=15), 'newborn disease' (n=13), 'injuries' (n=14), and 'neurologic disease' (n=10), with occurrences ranging from 1 to 15, links from 17 to 137, and total link strengths from 24 to 421. Cluster 5 (Purple): Keywords related to 'traditional medicine' and 'medicinal plants' (n=5) each, and 'skin diseases' (n=2), with occurrences ranging from 2 to 5, links from 2 to 82, and total link strengths from 4 to 92. Cluster 6 (Aqua): Keywords related to 'altitude disease' and 'altitude sickness' with (n=7) each, and 'pulmonary oedema' (n=4), with occurrences ranging from 4 to 7, links from 3 to 4, and total link strengths from 8 to 14. Cluster 7 (Orange): A single keyword, 'Japanese encephalitis' (n=1), indicates a specific focus on this disease, with an occurrence of one, a single link, and a TLS of one.

High-Cited Papers

Of the 326 HCPs in medical sciences from Nepal, the top 20 papers (6.13%) received 1888 to 10719 citations and were published from 2012-2021. They together received 90162 citations, averaging 4508.1 citations per paper. Of the top 20 HCPs, the largest number of papers (6) appeared in 2018, followed by 5 in 2017, 3 each in 2012 and 2020 and 1 each in 2016, 2019 and 2021. The 18 out of the top 20 HCPs appeared as articles, followed by reviews (2). All the 20 HCPs received external funding support and were involved in international collaboration.

The leading organizations participating in top 20 HCPs were Nepal Health Research Council (n=9), Manipal College of Medical Sciences, Pokhara, Nepal and Global Center for Research and Development, Kathmandu, Nepal (n=8 each), Ministry of Health and Population, Kathmandu, Nepal (n=6), Tribhuvan University, Kathmandu (n=6), B.P. Koirala Institute of Health Sciences and Abt Associates, Inc., Patan (n=5 each), etc.

The leading Nepalese authors participating in the top 20 HCPs from Nepal were K.K. Aryal (n=10), B. Sathian and C.L. Ranabhat (n=8 each), D. Acharya and S. Mehata (n=6 each), M. Dhimal (n=5), G.P. Dhungana and S.R. Mishra (n=3 each), N.B. Mahotra (n=2), etc.

The top 20 HCPs were published in 4 journals, of which *The Lancet* published 16 papers, followed by *The Lancet Neurology* (n=2), *Journal of the American Journal of Cardiology* and *New England Journal of Medicine* (n=1 each).

The HCP which ranked at the top of the list is entitled "Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: A systematic analysis for the Global Burden of Disease Study 2010." by R. Lozano, M., Naghavi. et al published in 2012 in The Lancet with the overall highest citations (10724 citations). This paper which ranked second is entitled "Global, regional, and National Incidence, prevalence, and Years Lived with Disability for 354 Diseases and Injuries for 195 Countries and Territories, 1990-2017: A Systematic Analysis for the Global Burden of Disease Study 2017" by S.L. James, D. Abate, et al. published in The Lancet in 2018 (8382 citations). The HCP at the bottom of the list is entitled "Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990-2016: A systematic analysis for the Global Burden of Disease Study 2016" authored by E. Gakidou, A. Afshin, et al published in The Lancet in 2017 (1888 citations).

DISCUSSION

This bibliometric study found a rising trend of publications in the field of medical research from Nepal and a total of 326 HCPs were identified. The externally funded research articles received much higher CPP than the average. The majority of HCPs (more than 95.0%) were involved in international collaboration with the main collobaroating countries being USA, followed by India, the UK, Australia, and China were the most active foreign collaborators. The leading Nepal organizations in medical research were Tribhuvan University, Kathmandu, Nepal Health Research Council (NHRC), and B.P. Koirala Institute of Health Sciences, Dharan. C.L. Ranabhat, B. Sathian, and K.K. Aryal were the most productive Nepalese authors. The non-communicable diseases were the most significant area of research, followed by communicable/infectious diseases, maternal, new-born and child health including reproductive health.

Several bibliometric studies have been conducted in the past, examining and assessing national science and technology publications of various countries, including the South Asia countries such as India [10,11], Pakistan[12], Bangladesh[13], Sri Lanka[14] and Nepal.[15,16] More recently, there has been interest among researchers in analyzing HCPs of a specific country/territory, such as focusing on India etc.[17,18] Besides conducting bibliometric studies at the national level, a select number of bibliometric studies have examined national publication output in health and medical sciences of various countries, including India[19,20], Pakistan[21], Sri Lanka[22] and Nepal.[23] Although numerous studies have been conducted in the past to identify and examine the high-cited papers (HCPs) in the various sub-fields of medicine at the global level, such as health care[24], health policy[25], etc., except for UK[26]. However, few bibliometric studies have been undertaken to study specific sub-fields of medical research in South Asia[27], India[28-31], Bangladesh[32], and Nepal level[33-35], but no bibliometric study has been undertaken which examined high-cited publications in the health and medical sciences at the national level in Nepal.

The present bibliometric analysis of HCPs in Nepal reveals valuable information about medical research in the country. This analysis has helped identify leading researchers, institutions, and areas of research strength. This information can be used to improve future research efforts and policies in Nepal. Bibliometric analysis is often been utilised for research analysis, to uncover emerging trends in article and journal performance, collaboration patterns, and research constituents, and to explore the intellectual structure of a specific domain in the existing literature.[29-32] In a bibliometric study using Scopus data, from 1996-2022, it was reported that in all subject areas, the global ranking of Nepal was 89 (out of 243), and among Asian countries, it was 18 (out of 33). Whereas, in all medical subjects its global ranking was 78 (out of 240), and among Asian countries, it was 14 (out of 33). There are several challenges and needs in medical research in LMIC like professionals' brain drain, lack of research capacity and limited resources etc. These challenges need to be addressed effectively to enhance the research in Nepal.[35] Nepal's most impactful medical research often involves international collaboration and funding. However, there seems to be a lack of collaboration between Nepalese organizations themselves. To address local health issues more effectively, Nepal should focus on fostering national research collaborations. This could lead to more homegrown, cost-effective solutions.

Bibliometrics use statistical methods to analyze scholarly publications, and is a powerful tool for understanding research trends and impact. However, it is s important to recognize that bibliometrics have some limitations like focus on quantity, and not quality of research. The accuracy of bibliometric analysis hinges on the quality of the data sources, such as Scopus or Web of Science, which might have incomplete information, with missing author names or incorrectly categorized publications. Mixing data from different sources like Scopus and Web of Science (WoS) in bibliometric studies requires caution due to several reasons. The databases have different inclusion criteria and indexing practices. Merging data can lead to double-counting publications with slight variations or missing information from one source but present in the other. Databases utilize different algorithms for citation tracking and impact factors. Combining data would mean merging metrics that aren't directly comparable, potentially skewing your results. Merging datasets requires meticulous cleaning to identify and remove duplicates, standardize formats, and ensure data integrity. This can be a significant time investment. Assigning credit for collaborative research can be tricky. Metrics like total citations per author may not accurately reflect individual contributions in multi-authored papers. Some of the authors in this study were involved in the collaboration at Global Burden of Disease studies by University of Washington, and hence have the majority of citations, which give a false impression of true research originating from Nepalese authors.

CONCLUSIONS

Nepal's medical research output has grown significantly over the three decades. Most (around 95%) of Nepal's highly-cited research involved international collaboration, with only a small portion being purely national. Additionally, about half received external funding. These findings highlight the importance of collaboration and funding for impactful research in Nepal. The leading research areas include non-communicable diseases, followed by infectious diseases and maternal/child health. Notably, all of Nepal's top medical institutions contributed to these publications.

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