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Clinical Neuroscience Research in Saudi Arabia: A Comparative Evaluation of Performance at Country and Worldwide Levels Based on the Relative Specialization Index

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Abstract

This review is an appraisal of the performance of clinical neuroscience research in Saudi Arabia based on the measurement of the Relative Specialization Index (RSI). The latter is an established quantitative performance indicator that determines whether a country has a relatively higher or lower share in world publications in a specialty than its overall part in the world total publications. The study aimed to assess the trends in the specialty's RSI, comparing it to other medical specialties in Saudi Arabia and to that of the top 50 countries worldwide in clinical neuroscience. SCImago Journal and Country Rank were used to determine the total articles and total citations for 46 medical specialties in Saudi Arabia and clinical neuroscience in the worldwide top 50 countries during 1996- 2023. The RSI was calculated for each medical specialty and each country. A positive or negative RSI implied that the specialty's share in the country's total documents or total citations was higher or lower than the average for the specialty worldwide. A steady increase in Saudi Arabia's total articles and total citations in clinical neuroscience was observed over the last 28 years. The RSI values, however, remained negative throughout except for limited periods (2003-2006 for total articles) and (1996 and 1998 for total citations). Compared to other medical specialties in Saudi Arabia, the specialization performance for clinical neuroscience was within the mid-range in total articles (ranking 30th out of 46 specialties) and the low range in total citations (ranking 39th out of 46 specialties). Saudi Arabia's worldwide ranking in clinical neuroscience based on total citations was 39; however, the country's ranking dropped to 45 when the RSI values were applied. Furthermore, clinical neuroscience was considered to have had a strong relative contribution (RSI > 0.1) to the total articles in five countries (Italy, Austria, Germany, Japan, and Canada) and total citations in six countries (Luxembourg, Austria, Germany, Canada, Italy, and Finland). In conclusion, despite an increase in Saudi Arabia's total articles and total citations in clinical neuroscience over the years, the specialty's relative share of the total productivity in the country remains lower than the overall for the specialty worldwide. The performance of the specialty was within the mid-to-low range compared to the other 45 medical specialties in Saudi Arabia. In addition, the country's worldwide ranking based on total citations in the specialty dropped when the RSI was used. Clinical neuroscience researchers in Saudi Arabia are encouraged to improve the quality and quantity of their research productivity to be one of the leading medical specialties in Saudi Arabia.

Categories: Neurology, Neurosurgery, Medical Education

Keywords: bibliometrics, medical specialty research, worldwide ranking, scimago journal and country rank, relative specialization index, clinical neuroscience, saudi arabia

Introduction And Background

Evaluation of medical specialties' global productivity and worldwide ranking have been the subject of several publications and remain a matter of interest [1-5]. SCImago Journal and Country Rank (SJR) [6] is an online free-access portal that utilizes the Scopus database and provides lists of worldwide rankings for countries and journals based on several bibliometric indicators [1-3,7]. The Relative Specialization Index (RSI) is an established quantitative performance indicator that determines whether a country has a relatively higher or lower share in world publications in a specialty than its overall part in the world total publications. It is derived from the Activity Index (AI), which was first introduced by Frame in 1977 and further developed by others [8,9]. The index allows for benchmarking the position of a country in a specific specialty against the world's average. Specialties in a country where RSI>0 indicate relative specialization in that particular field. The overall RSI score for a country should always be 0, which means that positive RSI values must always be balanced by negative ones [8,9]. In recent years, few studies reported the use of RSI measurements in assessing the specialization distribution in Saudi Arabia [2], the Netherlands, and China [8] and relating to tissue engineering in otolaryngology in several countries [10].

How to cite this article

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Over the last four decades, researchers from Saudi Arabia have contributed to the national and international medical and biomedical literature. Meo et al. [11]. reported that the country's research performance in global medical sciences had markedly increased during the period 2006-2012, but the number of citations had decreased. Latif [12] described a linear progression in Saudi Arabia's biomedical research production during 2008-2012, but most publications were in low Impact Factor (IF) journals. Al-Bishri [13] reviewed Saudi Arabia's total publications during 2010-2011 and reported that most of the articles were in the fields of community medicine, pathology, medicine, and surgery. More recently, Ul-Haq et al. [14] demonstrated that the total publications increased considerably from 1,332 in 2008 to 5,529 in 2017 and that medicine was the most prominent subject area. Furthermore, Vennu et al. [15] stated that the number of publications carried out by Saudi Arabia's universities increased significantly from 73 in 2008 to 721 in 2017. However, most articles (80%) were published in journals with IF<3. The appraisal of Saudi Arabia's research in clinical neuroscience has been limited to a few articles that analyze the country's research production in epilepsy, neurology, and neurosurgery [16-18]. Three articles addressed Saudi Arabia's productivity and worldwide ranking in clinical neuroscience [4,19,20]. However, the data reported in these articles were limited to 2018, and the specialty's RSI was not measured. The purpose of the study was to evaluate clinical neuroscience's share of total productivity in Saudi Arabia as measured by the RSI. The review aimed to highlight the changing trends in the specialty's RSI over the years and compare it to other medical fields in Saudi Arabia and the top 50 countries in the specialty worldwide. The study also intended to identify the countries in which clinical neuroscience's contribution to their total research was higher than the overall for the specialty worldwide.

Review

Methods

This study was a review based on routinely available data with open access; hence, it did not require ethical approval by our institution. The SJR [6] was searched during July 2024 using the parameters "medicine," "clinical neurology," "each year from 1996 to 2023," and "all regions." The data collected was Saudi Arabia's total articles and total citations, as well as the country's worldwide ranking based on total articles and total citations in the specialty each year. A second SJR search was carried out utilizing the parameters "medicine," "each of the listed 48 medical specialties in the SJR website," "1996-2023," and "all regions." The subject categories 'Drug Guides' and 'Medical Reviews and References' were excluded due to limited participation by researchers from Saudi Arabia. The data collected was Saudi Arabia's total articles and total citations, as well as the country's worldwide ranking in each of the 46 medical specialties based on total articles and total citations during the searched period. A third search of the SJR website was performed employing the parameters "medicine," "clinical neurology," "1996-2023," and "all regions." The data collected were total articles worldwide and total citations for each of the top 50 countries in the world in the specialty during the searched period.

The subject category "clinical neurology" on the SJR website included 396 international journals that cover a range of clinical neuroscience specialties [6]. Hence, it was considered appropriate to refer to "clinical neurology" in the SJR site as "clinical neuroscience" thereafter in this article. The data obtained were used to calculate the AI and RSI based on total articles and total citations for clinical neuroscience in Saudi Arabia in each year from 1996 to 2023, for each of the 46 medical specialties in Saudi Arabia during 1996-2023, and for each of the top 50 countries worldwide in clinical neuroscience during 1996-2023. The AI and RSI were calculated using the following bibliometric formulae [2, 8, 10]:

$$AI = [(Specialty\ total\ articles/cites\ in\ Saudi\ Arabia) \div (All\ specialties\ total\ articles/citations\ in\ Saudi\ Arabia)]$$

÷

$$[(Specialty\ total\ articles/citations\ in\ the\ world) \div (All\ specialties\ total\ articles/cites\ in\ the\ world)]$$

$$RSI = (AI - 1) \div (AI + 1)$$

The RSI has values that range from -1 to +1. An RSI>0 indicates above-world average productivity in the specialty, while an RSI<0 indicates below-world average. In this study, RSI>0.1 in total articles or total citations was labeled as a strong relative contribution by the country to the specialty, whether clinical neuroscience or any other specialty. The RSI values of total articles and total citations for the top 50 countries were correlated with their worldwide rankings by calculating Pearson's correlation coefficient (R) using Social Sciences Statistics [21], with significance being reached when P<0.05.

Results

Data relating to the performance of clinical neuroscience in Saudi Arabia were analyzed in the three following categories.

Trends of the Years

Total articles and total citation rankings worldwide for clinical neuroscience in Saudi Arabia from 1996 to 2023 are shown in Table 1.

| Year | Worldwide ranking (total articles) | Worldwide ranking (total citations) |
|------|------------------------------------|-------------------------------------|
| 1996 | 32 | 33 |
| 1997 | 37 | 37 |
| 1998 | 34 | 34 |
| 1999 | 36 | 38 |
| 2000 | 39 | 42 |
| 2001 | 45 | 44 |
| 2002 | 38 | 40 |
| 2003 | 35 | 39 |
| 2004 | 36 | 43 |
| 2005 | 38 | 47 |
| 2006 | 37 | 47 |
| 2007 | 41 | 52 |
| 2008 | 38 | 45 |
| 2009 | 41 | 52 |
| 2010 | 40 | 45 |
| 2011 | 40 | 39 |
| 2012 | 44 | 39 |
| 2013 | 39 | 41 |
| 2014 | 38 | 35 |
| 2015 | 39 | 40 |
| 2016 | 36 | 38 |
| 2017 | 35 | 38 |
| 2018 | 34 | 38 |
| 2019 | 34 | 34 |
| 2020 | 32 | 36 |
| 2021 | 34 | 35 |
| 2022 | 33 | 39 |
| 2023 | 28 | 37 |

TABLE 1: Annual worldwide ranking for clinical neuroscience in Saudi Arabia based on total articles and total citations between 1996 to 2023

During that period, the median (range) total articles and total citations were 75 (22 - 401) and 1,148 (275 - 7,403), respectively; the median (range) total articles and total citations worldwide rankings were 37 (28 - 45) and 39 (33 - 52), respectively; and the median (range) RSI values of total articles and total citations were -0.1681 (-0.3333 - 0.1241) and -0.2697 (-0.5671 - 0.031), respectively. A steady increase was observed in the country's total articles that was most marked from 2012 to 2023. During that period, the annual number of articles increased from 82 to 401, which coincided with an improvement in Saudi Arabia's worldwide ranking in the specialty from 44 to 28. However, this did not correspond with an increase in the RSI value of total articles, which remained negative throughout the period, ranging from -0.3234 to -0.2454. The RSI value of

total articles was noted to be positive for a relatively short period (2003-2006). The trends in the performance of clinical neuroscience in Saudi Arabia are illustrated in Figure 1 for total articles, Figure 2 for worldwide rankings, and Figure 3 for RSI values.

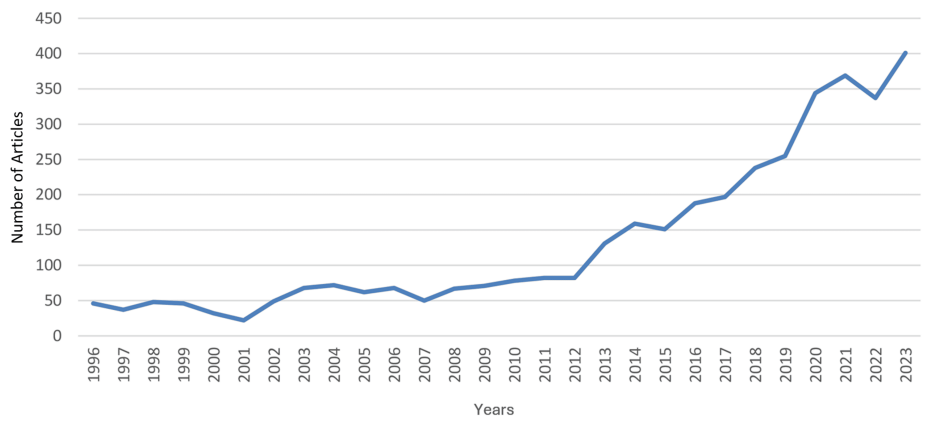


FIGURE 1: Saudi Arabia's annual number of articles on clinical neuroscience between 1996 and 2023

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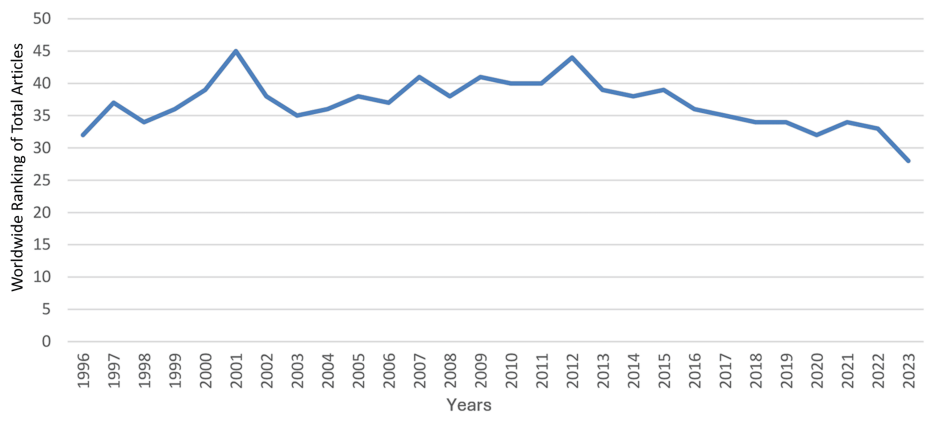


FIGURE 2: Worldwide ranking of Saudi Arabia's annual total articles on clinical neuroscience from 1996 to 2023

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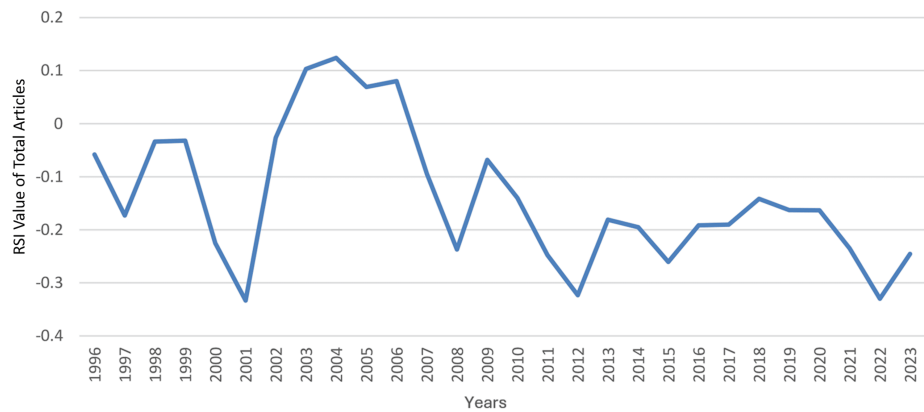


FIGURE 3: The RSI value of Saudi Arabia's annual total articles on clinical neuroscience from 1996 to 2023

RSI: Relative Specialization Index

This graph has been created by the authors.

An obvious increase was noted in the country's total citations which was most evident from 2009 to 2019. During that period, the annual number of citations increased from 883 to 7,403, which coincided with an improvement in the country's worldwide ranking from 52 to 34 and an increase in the RSI value of total citations from -0.4075 to -0.0016. The RSI value of total citations was recorded positive in two years only (1996 and 1998), and recently there had been a decline from its best value in 2019 (-0.0016) to its worst in 2022 (-0.5671). The trends in the performance of clinical neuroscience in Saudi Arabia are illustrated in Figure 4 for total citations, Figure 5 for worldwide rankings, and Figure 6 for RSI values.

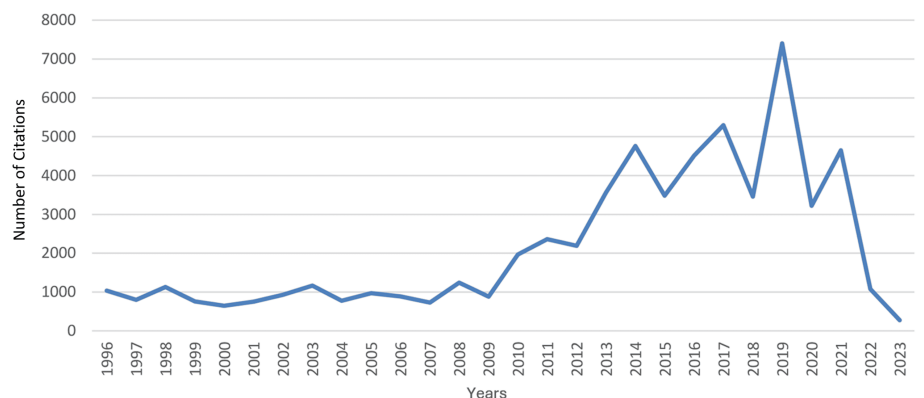


FIGURE 4: Saudi Arabia's annual number of citations in clinical neuroscience during the years 1996-2023

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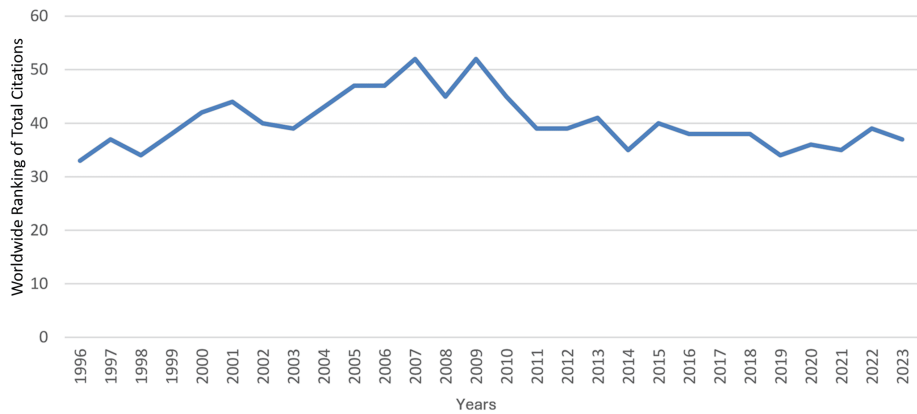


FIGURE 5: Worldwide ranking of Saudi Arabia's annual total citations in clinical neuroscience from 1996 to 2023

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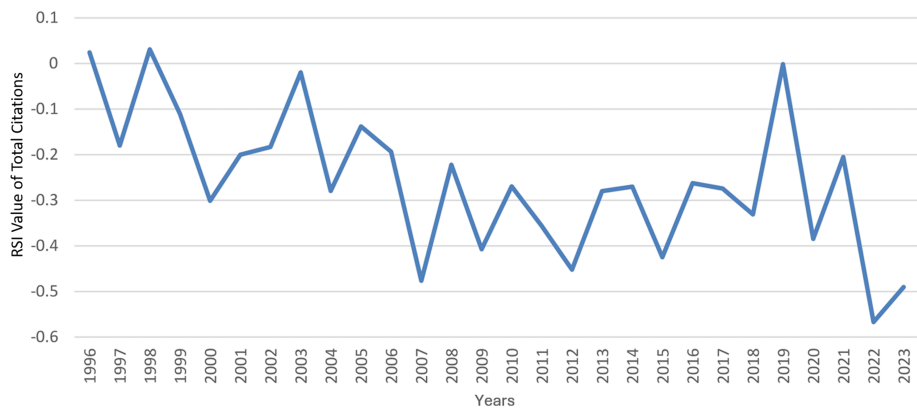


FIGURE 6: The RSI values of Saudi Arabia's annual total citations in clinical neuroscience between 1996 and 2023

RSI: Relative Specialization Index

This graph has been created by the authors.

Comparison to Other Medical Specialties in Saudi Arabia

Total articles and total citations rankings worldwide for 46 medical specialties in Saudi Arabia during 1996-2023 are shown in Table 2.

| Worldwide ranking of specialties listed by total articles | Worldwide ranking of total articles | Worldwide ranking of specialties listed by total citations | Worldwide ranking of total citations |
|---|-------------------------------------|--|--------------------------------------|
| Family practice | 19 | Family practice | 22 |
| Health informatics | 22 | Complementary medicine | 26 |
| Complementary medicine | 25 | Health informatics | 28 |
| Transplantation | 25 | Ophthalmology | 28 |
| Ophthalmology | 26 | Critical care | 32 |
| Biochemistry | 28 | Biochemistry | 33 |
| Otolaryngology | 29 | Transplantation | 33 |

| | | | |
|----------------------------|----|---------------------------|----|
| Pharmacology | 29 | Genetics | 34 |
| Genetics | 29 | Otolaryngology | 34 |
| Urology | 29 | Microbiology | 35 |
| Anatomy | 30 | Pharmacology | 35 |
| Medicine (Miscellaneous) | 31 | Urology | 35 |
| Nephrology | 31 | Anatomy | 36 |
| Histology | 32 | Anesthesiology | 36 |
| Dermatology | 33 | Radiology | 36 |
| Hematology | 33 | Surgery | 36 |
| Surgery | 33 | Haematology | 37 |
| Endocrinology | 34 | Pediatrics | 38 |
| Microbiology | 34 | Pulmonology | 38 |
| Health policy | 35 | Dermatology | 39 |
| Infectious disease | 35 | Emergency medicine | 39 |
| Public health | 35 | Endocrinology | 39 |
| Radiology | 35 | Infectious disease | 39 |
| Emergency medicine | 36 | Internal medicine | 39 |
| Pediatrics | 36 | Medicine (miscellaneous) | 39 |
| Pulmonology | 36 | Neuroscience | 39 |
| Oncology | 37 | Public health | 39 |
| Rehabilitation | 37 | Pathology | 40 |
| Anesthesiology | 38 | Physiology | 40 |
| Critical care | 38 | Geriatrics | 41 |
| Cardiology | 39 | Health policy | 41 |
| Immunology | 39 | Nephrology | 41 |
| Internal medicine | 39 | Oncology | 41 |
| Neuroscience | 39 | Orthopedics | 41 |
| Pathology | 39 | Rehabilitation | 41 |
| Embryology | 40 | Reproductive medicine | 41 |
| Orthopedics | 41 | Histology | 42 |
| Epidemiology | 42 | Cardiology | 43 |
| Gastroenterology | 42 | Embryology | 43 |
| Psychiatry | 42 | Gastroenterology | 43 |
| Reproductive medicine | 42 | Epidemiology | 44 |
| Geriatrics and gerontology | 43 | Hepatology | 44 |
| Rheumatology | 43 | Immunology | 44 |
| Hepatology | 44 | Obstetrics and gynecology | 44 |
| Physiology | 44 | Rheumatology | 45 |
| Obstetrics and gynecology | 45 | Psychiatry | 46 |

TABLE 2: Worldwide ranking of 46 medical specialties in Saudi Arabia based on total number of articles and total citations from 1996 to 2023

The median (range) total articles and total citations for all the specialties were 1,570 (81-53,888) and 24,966 (1293-1008,766), respectively. The median (range) total articles and total citations worldwide rankings were 36 (19-45) and 39 (22-46), respectively. The median (range) RSI values of total articles and total citations were -0.0989 (-0.4933-0.3489) and -0.0976 (-0.5047-0.4755), respectively. Thirty specialties had a worldwide ranking of total articles between 19 and 38, which were better than clinical neuroscience's worldwide ranking of 39. Hence, based on the total articles worldwide ranking, clinical neuroscience could be considered 31st among the 46 specialties in Saudi Arabia. Twenty-nine of the 46 medical specialties had total articles RSI values that were better than those for clinical neuroscience (>-0.196). Hence, based on the RSI values of total articles, clinical neuroscience could be considered as ranking 30th amongst the 46 specialties in Saudi Arabia. The RSI value for total articles for all the specialties is illustrated in Figures 7-8.

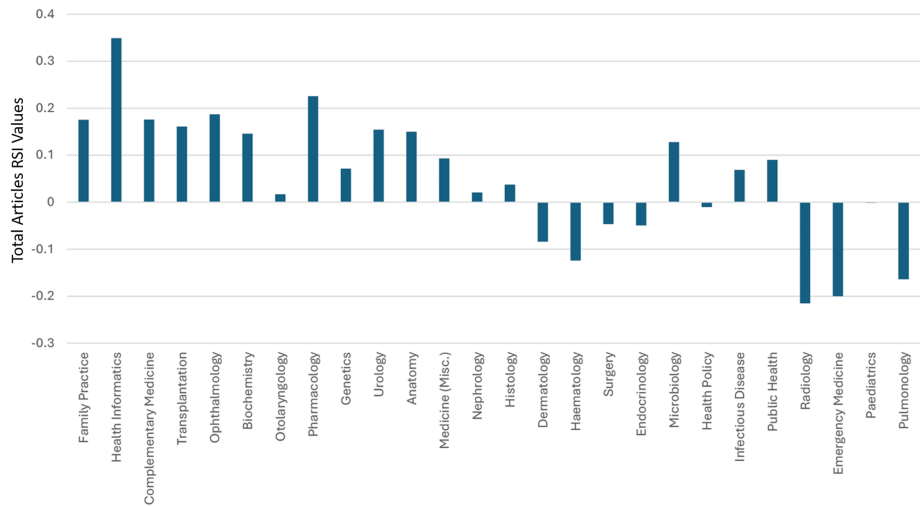


FIGURE 7: The RSI values of Saudi Arabia's total articles in the specialties that had a worldwide ranking of 36 or better

RSI: Relative Specialization Index; Misc.: miscellaneous

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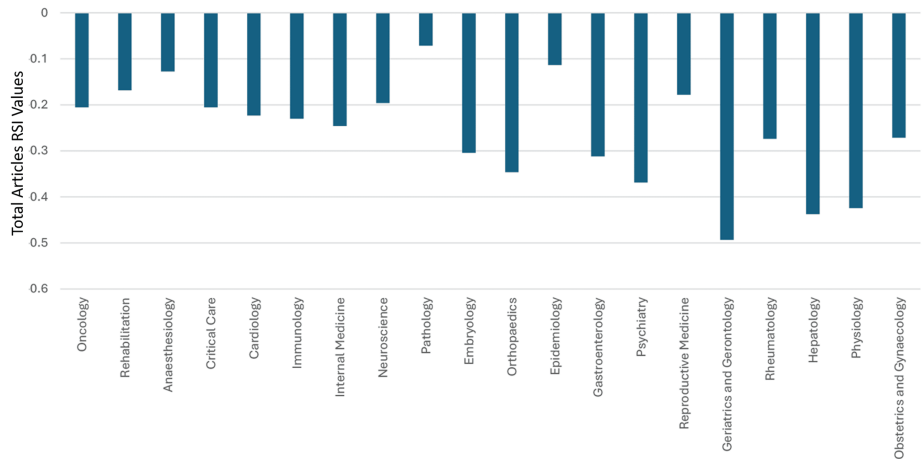


FIGURE 8: The RSI values of Saudi Arabia’s total articles in specialties that had a worldwide ranking of 37 or worse

RSI: Relative Specialization Index
This graph has been created by the authors.

Nineteen specialties had total citations worldwide rankings between 22 and 38, which was better than clinical neuroscience’s worldwide ranking of 39. Hence, based on total citations worldwide rankings, clinical neuroscience could be considered as ranking 20th among the 46 specialties in Saudi Arabia. Thirty-eight of the 46 medical specialties had total citation RSI values that were better than those for clinical neuroscience (>-0.294). Hence, based on total citation RSI values, clinical neuroscience can be considered as ranking 39th amongst the 46 specialties in Saudi Arabia. The total citations RSI value for 46 specialties in Saudi Arabia during 1996-2023 is illustrated in Figures 9-10.

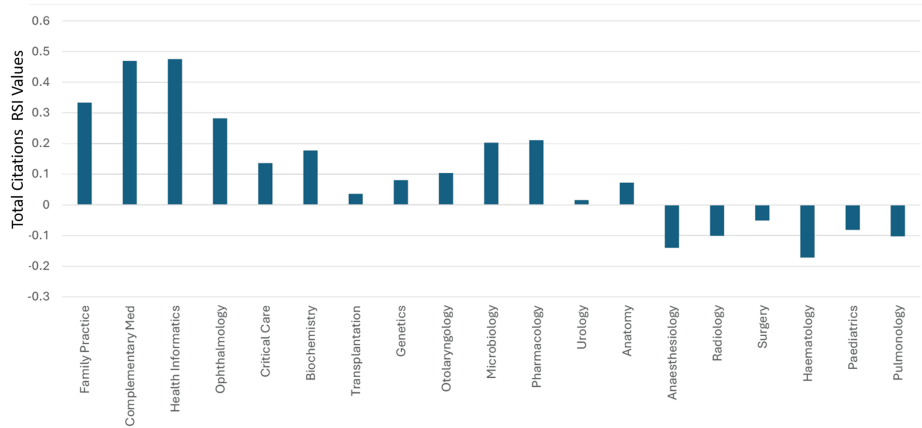


FIGURE 9: The RSI values of Saudi Arabia’s total citations in the specialties that had a worldwide ranking of 38 or better

RSI: Relative Specialization Index
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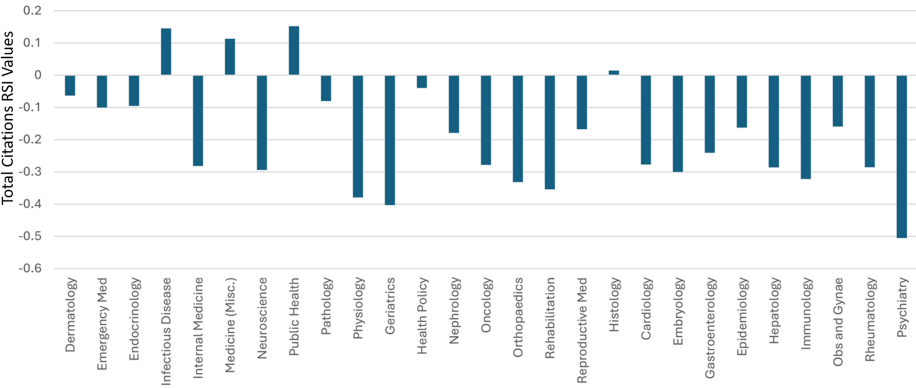


FIGURE 10: The RSI Values of Saudi Arabia’s total citations in the specialties that had a worldwide ranking of 39 or worse

RSI: Relative Specialization Index; Misc.: miscellaneous

This graph has been created by the authors.

Comparison to Top 50 Countries in Clinical Neuroscience, Worldwide

The top 50 countries based on total articles and total citations in clinical neuroscience from 1996–2023 are listed in Table 3.

| Countries ranked by total articles in clinical neuroscience | Worldwide ranking based on total articles | Countries ranked by total citations in clinical neuroscience | Worldwide ranking based on total citations |
|---|---|--|--|
| USA | 1 | USA | 1 |
| Germany | 2 | UK | 2 |
| Japan | 3 | Germany | 3 |
| UK | 4 | Canada | 4 |
| Italy | 5 | Italy | 5 |
| China | 6 | France | 6 |
| Canada | 7 | Japan | 7 |
| France | 8 | Netherlands | 8 |
| Spain | 9 | Australia | 9 |
| Australia | 10 | Spain | 10 |
| Netherlands | 11 | Sweden | 11 |
| India | 12 | China | 12 |
| Switzerland | 13 | Switzerland | 13 |
| South Korea | 14 | Belgium | 14 |
| Brazil | 15 | Austria | 15 |
| Turkey | 16 | Denmark | 16 |
| Sweden | 17 | South Korea | 17 |
| Belgium | 18 | Brazil | 18 |
| Austria | 19 | Finland | 19 |
| Denmark | 20 | Israel | 20 |

| | | | |
|----------------|----|----------------|----|
| Taiwan | 21 | Norway | 21 |
| Israel | 22 | Turkey | 22 |
| Russia | 23 | India | 23 |
| Poland | 24 | Taiwan | 24 |
| Iran | 25 | Portugal | 25 |
| Finland | 26 | Poland | 26 |
| Norway | 27 | Greece | 27 |
| Czech Republic | 28 | Ireland | 28 |
| Greece | 29 | New Zealand | 29 |
| Portugal | 30 | Argentina | 30 |
| Mexico | 31 | Hong Kong | 31 |
| Argentina | 32 | Czech Republic | 32 |
| Ireland | 33 | Hungary | 33 |
| Hungary | 34 | Iran | 34 |
| Singapore | 35 | Singapore | 35 |
| New Zealand | 36 | Russia | 36 |
| Hong Kong | 37 | Mexico | 37 |
| Egypt | 38 | South Africa | 38 |
| Saudi Arabia | 39 | Saudi Arabia | 39 |
| Chile | 40 | Chile | 40 |
| Thailand | 41 | Egypt | 41 |
| South Africa | 42 | Thailand | 42 |
| Colombia | 43 | Serbia | 43 |
| Romania | 44 | Colombia | 44 |
| Malaysia | 45 | Malaysia | 45 |
| Croatia | 46 | Romania | 46 |
| Serbia | 47 | Slovenia | 47 |
| Slovakia | 48 | Croatia | 48 |
| Nigeria | 49 | Slovakia | 49 |
| Pakistan | 50 | Luxembourg | 50 |

TABLE 3: Worldwide ranking of top 50 countries in clinical neuroscience based on total articles and total citations between 1996 to 2023

The median (range) total articles and total citations for the top 50 countries in clinical neuroscience were 8,307 (1,200-336,122) and 188,337 (26,016-12517,536), respectively. The median (range) RSI values of total articles and total citations among the top 50 countries in the specialty were -0.054 (-0.6012- 0.1504) and -0.0568 (-0.4464- 1), respectively. Saudi Arabia's total articles in the specialty were 3,750. The country was ranked 39 and had a total articles RSI value of -0.196. Thirty-eight countries had total articles RSI values that were better than those of Saudi Arabia. Hence, based on total articles RSI values in clinical neuroscience, Saudi Arabia could be considered as ranking 39th in the world. In addition, based on having an RSI>0.1, clinical neuroscience was considered to have had a strong relative contribution to the total articles in five countries. These were Italy, Austria, Germany, Japan, and Canada. The total articles RSI values for the top 50 countries are illustrated in Figures [11-12](#).

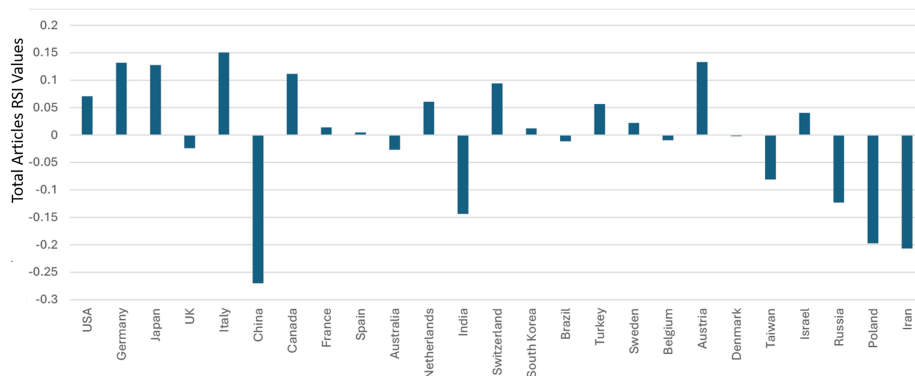


FIGURE 11: The RSI values of the total articles in the countries that were ranked between one and 25 worldwide in clinical neuroscience specialty

RSI: Relative Specialization Index

This graph has been created by the authors.

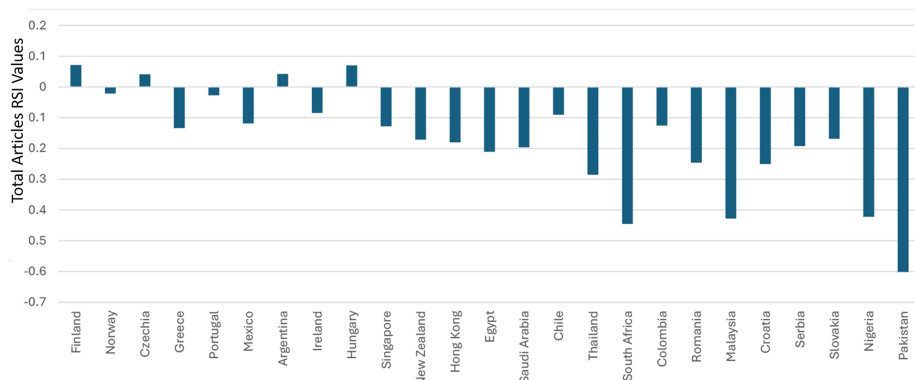


FIGURE 12: The RSI values of the total articles in the countries that were ranked between 26-50 worldwide in clinical neuroscience specialty

RSI: Relative Specialization Index

This graph has been created by the authors.

Saudi Arabia's total citations in the specialty were 60,903. The country was ranked 39th and had a total citation RSI value of -0.294. Forty-four countries had total citations RSI values that were better than that of Saudi Arabia. Hence, based on total citation RSI values in clinical neuroscience, Saudi Arabia can be considered as ranking 45th in the world. Based on having an $RSI \geq 0.1$, clinical neuroscience was considered to have had a strong relative contribution to the total citations in six countries. These were Luxembourg, Austria, Germany, Canada, Italy, and Finland. The total citation RSI values for the top 50 countries are illustrated in Figures 13-14. The correlation analysis between the total articles RSI values and the total articles worldwide rankings for the top 50 countries showed a significant association ($R = -0.7136$, $P < 0.0001$). The correlation assessment between the total citation RSI values and total citation worldwide rankings for the top 50 countries also showed a positive link ($R = 0.3368$) ($P = 0.0167$).

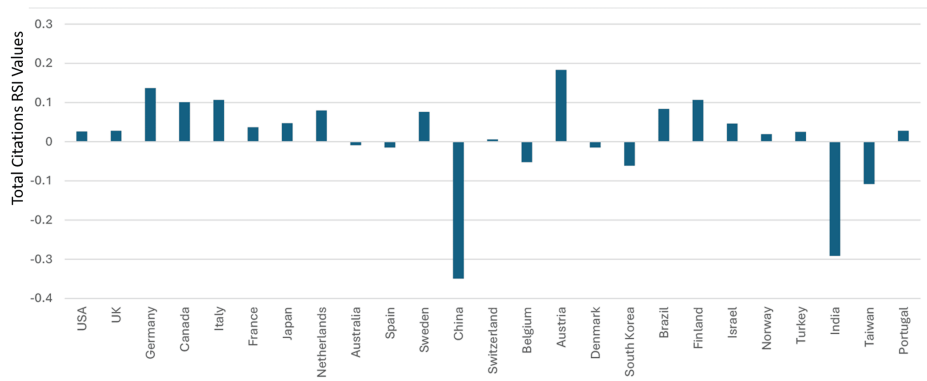


FIGURE 13: The RSI values of total citations in the countries that were ranked between one and 25 worldwide in clinical neuroscience specialty

RSI: Relative Specialization Index

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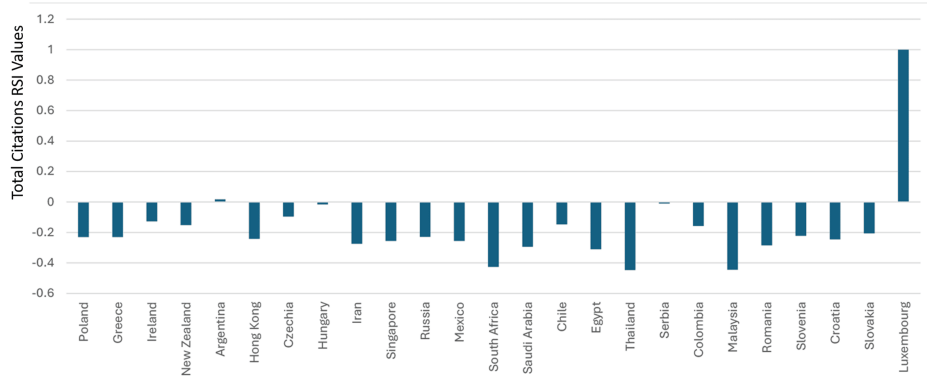


FIGURE 14: The RSI values of total citations in the countries that were ranked between 26 and 50 worldwide in clinical neuroscience specialty

RSI: Relative Specialization Index

This graph has been created by the authors.

Discussion

The first medical journal from Saudi Arabia, the Saudi Medical Journal, was established in 1979, and in the years up to 2014, 20 other Saudi journals covering a wide range of medical specialties were launched [2]. Of the latter, only eight journals are currently listed on the SJR website [6]. One of the Saudi journals is a neuroscience journal that is referred to in PubMed as “Neurosciences (Riyadh)” [2, 22]. It is an open-access, peer-reviewed, quarterly publication with nearly 60% of its original articles coming from outside Saudi Arabia [22]. Despite being launched in 1996, the IF of Neurosciences (Riyadh) remains modest, and nearly two-thirds of its research publications are of level evidence (LOE) IV [22].

The RSI measurement in this review allowed us to quantify the share of the clinical neuroscience research out of Saudi Arabia’s total academic productivity. The RSI is a well-recognized bibliometric performance indicator that is calculated using productivity data such as total articles and total citations. Several factors are known to influence a country’s scientific output and would indirectly impact the RSI values. These include many country-specific characteristics such as gross domestic product (GDP) per capita, GDP spending on research and developments (R & D), number of universities among the top 500 in the world, number of Institute of Scientific Information (ISI)-indexed journals, and population size [1, 4]. Furthermore, variation in the amount of publishing between the various medical specialties is well recognized [2,23]. Also well-documented is the wide disparity in productivity among some countries even when the number of

specialists is normalized [24].

This review assessed the performance of clinical neuroscience in Saudi Arabia over 28 years (1996–2023). In the last three decades, Saudi Arabia saw considerable growth in the number of researchers, research centers, research resources, and universities [2,4,14,15]. The country also observed an increase in access to collaborative research and training opportunities abroad, as well as the launch of several local journals [2,4,14,22]. The transformation in the country's research facilities would have most likely affected productivity and impacted the data in the review. We were able to demonstrate that despite a clear-cut increase in the total articles and total citations of clinical neuroscience in Saudi Arabia during 1996–2023, the specialty's share of the country's productivity fluctuated and remained negative during most of the period, reflecting a lower than the world's average. The brief periods of RSI positivity for total articles (2003–2006) and total citations (1996–1998) may have signaled personal efforts by an active cohort of researchers at the time.

We were able to rank clinical neuroscience among the other 45 specialties in Saudi Arabia based on the RSI performance. The specialty ranked 31 amongst the 46 specialties based on the total articles worldwide rankings, and the ranking remained almost unchanged (rank 30) based on the value of the total articles (RSI). In addition, the specialty ranked 20 amongst the 46 specialties based on total citations worldwide rankings. However, the ranking dropped to 39 based on the value of the total citations (RSI). These findings confirm that clinical neuroscience's share of the productivity in Saudi Arabia compared to the world's average can be considered mid-range for total articles and low-range for total citations when judged against other medical specialties in the country.

This study showed how the application of the RSI values impacted Saudi Arabia's worldwide ranking in clinical neuroscience. The country ranked 39 in the world based on the total number of articles in the specialty, and the ranking remained unchanged (rank 39) based on the value of the total articles (RSI). In addition, the country ranked 39 in the world based on total number of citations in the specialty. However, the ranking dropped to 45 based on the value of the total citations (RSI). The latter fits with frequently reported observations that Saudi Arabia's worst worldwide ranking in clinical neuroscience (134 in the world) was based on citations per article [6]. This was attributed to Saudi Arabian researchers publishing frequently low LOE research in low IF journals and local journals [1,4,11,13,25].

In addition, based on having an $RSI \geq 0.1$, we were able to identify countries among top 50 worldwide in which clinical neuroscience had a strong relative contribution to their productivity. For total articles, the countries (and their worldwide ranking) in the order of their RSI values were Italy (5th), Austria (19th), Germany (2nd), Japan (3rd), and Canada (7th). For total citations, the countries (and their worldwide ranking) in the order of their RSI values were Luxembourg (50th), Austria (15th), Germany (3rd), Italy (5th), Finland (19th), and Canada (4th). Despite the inclusion of three countries that were not highly ranked (Austria, Luxembourg, and Finland) among the groups in which clinical neuroscience had a strong relative contribution, a significant link between RSI values and rankings amongst the top 50 countries in the world in clinical neuroscience was observed.

There are several limitations to this study. The study was dependent on the accuracy of the website search engine SJR. It is possible that there were errors, particularly with multi-national publications. Furthermore, there may have been some specialty and topic overlap. The clinical neuroscience data covered a wide range of journals of varying subspecialties, ages, and IF. The impact of the change in the number of researchers involved over the years that would affect productivity was not examined. It can be argued that the two bibliometric indicators used (total articles and citations) may not provide a true reflection of the quality of research, particularly for publications in local journals. The total articles and citations for the medical specialties in Saudi Arabia were widely ranged. Hence, defining a specialty as having a strong relative contribution to productivity in the country based on $RSI \geq 0.1$ alone can be disputed. The influence of the presence of a Saudi specialty association or a specialty journal on the scientific productivity of the various medical specialties was not examined. The impact of the country-specific characteristics on the worldwide ranking in clinical neuroscience was not addressed.

Conclusions

In conclusion, despite an increase in the number of Saudi Arabia's total articles and total citations in clinical neuroscience over the years, the specialty's relative share of the total productivity in the country remains lower than the overall for the specialty worldwide. The specialization performance of the specialty was within the mid-to-low range compared to other medical specialties in Saudi Arabia. In addition, the country's worldwide ranking based on total citations in the specialty dropped when the RSI was used. Clinical neuroscience researchers in Saudi Arabia are encouraged to improve the quality and quantity of their research productivity to be one of the leading medical specialties in Saudi Arabia.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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