

# Scientific documentation of the Iranian radiopharmaceutical development program in the horizon 2025 in comparison to other regional competitors: A scientometric study

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## ABSTRACT

**Introduction:** Production and application of radiopharmaceuticals is one of the priorities in the comprehensive health map of Iran. The present study examines the scientific documentation of the Iranian radiopharmaceutical development program in the horizon 2025 in comparison to other regional competitors.

**Methods:** The present study is a descriptive review performed by the scientometric method. The sources of data collection are studies conducted in the Web of Science database (Clarivate Analytics) from 1992 to 2021. Excel software was used to collect data and data analysis.

**Results:** Among the countries in the horizon 2025, the highest rank of science production belongs to Iran and Turkey, each with 2.6%. The highest level of citation belongs to Turkey with 1.8% followed by Iran with 1.7%. Most of the radiopharmaceutical scientific productions and citations in Iran are recorded in 2020 (16.6% and 10.2%, respectively). The highest share of research area belongs to nuclear science technology with 37.1%. Iran has the most international cooperation with the United States (3.5%) and most citations from the scientific partnership with China (12.3%). Nuclear Science Research Center has the most share of science production and citations (22.1% and 7.1%, respectively). AR Jalilian is the top Iranian researcher with 11.5 percent of the total Iranian output in the radiopharmaceutical field.

**Conclusion:** Although Iran ranks first in the production of science and second in citation recorded among competing countries, there is a need for continuous comprehensive nuclear science research and development plan for quantitative and qualitative advancement of this field. In addition, the Iranian researchers require having more interaction, scientific communication and cooperation with academic center in countries with advanced technology in nuclear and health sciences, especially East Asian countries.

**Key words:** Radiopharmaceutical; Nuclear Science; Scientometric study; Comprehensive health Map

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## INTRODUCTION

Nuclear medicine is one of the technologies in the field of health and medicine dealing with diagnoses and treatments of disease by applying radiopharmaceuticals [1]. This rather new technology has experienced remarkable growth in recent years including in Iran, which has been investing in peaceful application of nuclear science and technology specially production of the radiopharmaceuticals [2]. During the past three decades, nuclear medicine has flourished as a vibrant and independent medical specialty in Iran [3], particularly in clinical applications (diagnosis and treatment) [4-7]. The advancement of radiological and pharmaceutical sciences in Iran has been discussed, internationally [2].

In the Middle East, pioneered the establishment of nuclear medicine centers throughout the country, covering many types of studies using radiopharmaceuticals. In 2016, the highest production capacity and distribution of radiopharmaceuticals in the region belonged to Iran, Israel and Turkey. This progress has taken place despite the widespread sanctions against Iran [8]. Therefore, radiopharmaceutical production technology along with corresponding management policies has been the subject of research in the country [2]. In addition, with the rapid development of nuclear knowledge, nuclear medicine, radiopharmacy, nanotechnology, and the combination of these new technologies, rapid advancement in radiopharmaceutical production has taken place, a source of continued interest in these new technologies. Following upstream documents, including the 20-year vision development document of the country and the third chapter of the comprehensive scientific health plan, which deals with the country's science and technology, the health sector remains one of the main priorities [9, 10]. Along with health science and technology priorities mentioned in the 20-year vision document, health working groups and comparative studies of 50 selected countries identified the comprehensive health map priorities. The "priority" disciplines are divided into three categories in this map consisting the constructive, survival, and perfection. Access to health technology has been considered in the perfection subset, where drug production and medical equipment production based on new technologies are the priorities [11].

To achieve the goals of the 20-year vision document of Iran in the field of health science and technology (reaching the first scientific rank in the region), monitoring the status of the country based on the scientometric studies is favorable.

## METHODS

The present study is a descriptive review that has been done using the scientometric method. The source of data collection is the Web of Science database. The

statistical population of the study is one of the priority fields of the comprehensive health map of Iran, which is in the packaging of the perfection category and is part of the scientific products in the field of radiopharmaceuticals, as well as five countries: Turkey, Pakistan, Egypt, Saudi Arabia, and Israel. According to studies conducted in the region, Iran is the main competitor in the region, so they were used as a basis for comparison in this study. To obtain the data of this study, after entering the site search page and selecting the advance option, search and enter keywords with TS = (Radiopharmaceutical- OR radioisotope) strategy. Then, either selecting the country/region field or restricting the desired data to the mentioned countries, the desired information was extracted using the analysis engine available in this database and selecting the received citation option and the number of production documents. The research periods from 1990 to 2021. Data analysis was performed using Excel software.

## RESULTS

Findings show that Iran and Turkey with 2.6%, Pakistan with 0.9%, Egypt with 0.8%, Saudi Arabia with 0.5%, and Israel with 0.4%, have done the scientific productions in the field of radiopharmaceuticals. On the other hand, in terms of citations rank, Turkey with 1.8 percent, Iran with 1.7 %, Egypt with 0.8 %, Israel with 0.7 %, Saudi Arabia with 0.5 %, and Pakistan with 0.4 %, have taken the scientific citations (Figure 1).

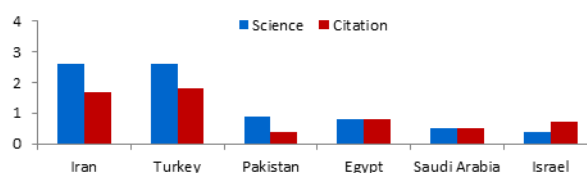


Fig 1. Iran rank in science production and citation.

The data in Figure 2 shows the trend of production of science and citation of radiopharmaceuticals in Iran in the last ten years in WOS.

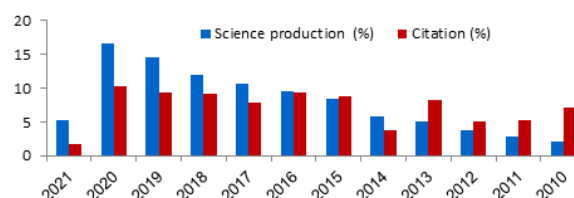


Fig 2. The Trend of radiopharmaceutical science production and citation in Iran (2010-2021).

This figure shows the highest frequency of various types of radiopharmaceutical products in Iran in the

last ten years, respectively, in 2021 with 5.2%, 2020 with 16.6%, 2019 with 14.6%, 2018 with 0.12%, 2017 with 10.6%, 2016 with 9.5%, 2015 with 8.4%, 2014 with 5.8%, 2013 with 0.5%, 2012 with 3.8%, 2011 with 2.8% and 2010 with 1.2%. The trend of citation of radiopharmaceuticals in Iran also shows in 2021 with 1.8%, 2020 with 10.2%, 2019 with 9.4%, 2018 with 9.1%, 2017 with 7%, 2016 with 4.49%, 2015 with 8.8%, 2014 with 3.7%, 2013 with 8.3%, 2012 with 5.1%, 2011 with 5.3% and 2010 with 7.2%.

Figure 3 shows the share of radiopharmaceutical research areas. The top research areas belong to; Nuclear science technology with 37.1%, nuclear medicine, radiology and imaging with 32.5%, inorganic nuclear chemistry with 22.3%, chemistry with 11.8%, pharmacy with 9.4%, nuclear physics with 6.9%, environmental sciences with 4.8%, medical chemistry and oncology with 3.7% and new tools and technologies with 3.2%.

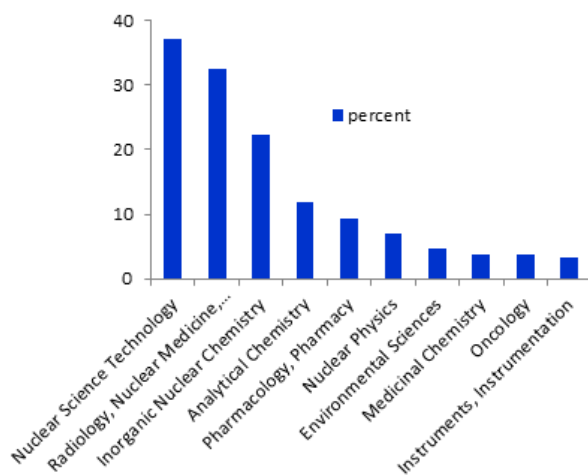


Fig 3. The distribution of radiopharmaceuticals research area in Iran.

Figure 4 shows the study of international cooperation and partnership between Iranian researchers in the field of radiopharmaceuticals. Accordingly, Iran has the highest scientific cooperation in this field with its the United States with 3.5%, Canada with 2.6%, Australia and South Korea with 2.1%, Germany, Italy, and Malaysia, respectively. With 1.6%, Chile with 1%, and Belgium and Austria with 0.8%.

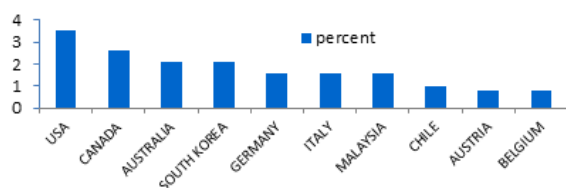


Fig 4. Comparing the frequency of Iran's international scientific cooperation with other countries of the world.

Figure 5 shows a list of the ten most productive and active radiopharmaceutical centers and organizations. Based on the findings; the order is Nuclear Science Research Center with 22.1%, Islamic Azad University with 13.9%, Tehran University of Medical Sciences with 13.1%, Nuclear Science and Technology Research Institute with 11.5%, the Amirkabir University of Technology with 8.1%, Atomic Energy Organization of Iran with 5.9%, Mazandaran University of Medical Sciences with 5.3%, Tarbiat Modares University with 5.1%, Shahid Beheshti University with 4.1% and Mashhad university medical science with 3.7%.

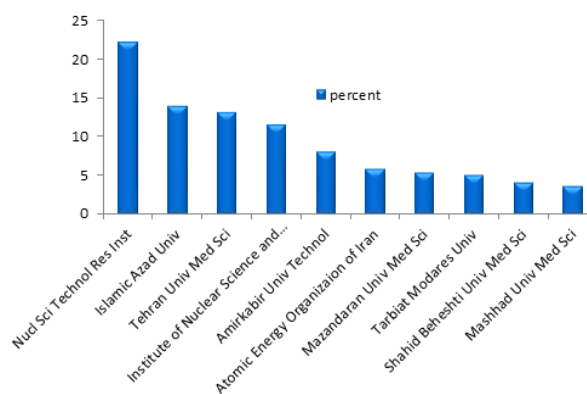


Fig 5. Top scientific organizations and centers in the field of radiopharmaceuticals in the production of science.

In Figure 6 details of the top 10 radiopharmaceutical scientists are shown. Accordingly, AR Jalilian had 11.5%, M Sadeghi 9.6%, A Bahrami- Samani 5.3%, M Ghannadi Maragheh, H Yousefnia and SJ Hosseinimehr 4.8%, D Beiki 4.3%, H Rajabi 3.5%, H Afrideh and SMS Kiai 3.2%.

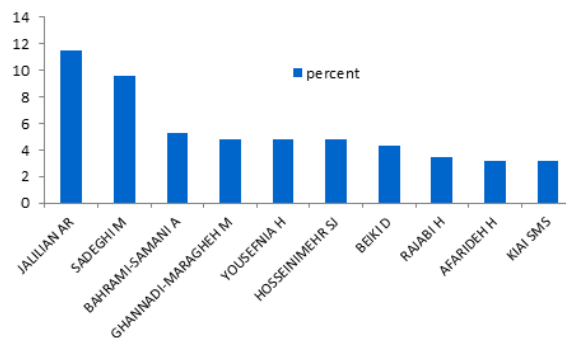


Fig 6. Top rank researchers in the field of radiopharmaceuticals.

Figure 7 shows the citation analysis of top organizations in the radiopharmaceutical subject area. Based on the findings; Nuclear Science Research Center with 7.1%, Islamic Azad University with 5.6%, Tehran University of Medical Sciences with 5.1%,

Nuclear Science and Technology Research Institute with 4.2%, Mazandaran University of Medical Sciences with 2.9%, Amirkabir University of Technology with 2.3%, Mashhad University of Medical Sciences with 2.1%, Shiraz University of Medical Sciences and Iran University of Medical Sciences with 1.9%.

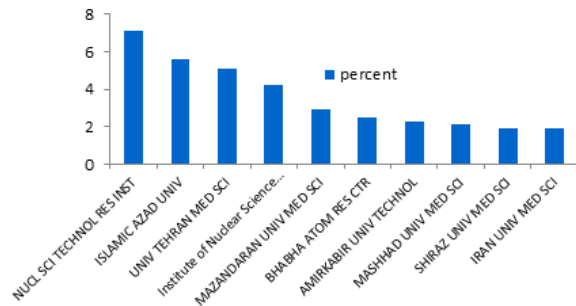


Fig 7. Citation analysis of top organizations in radiopharmaceutical subject area.

Figure 8 shows Iran's cooperation with the countries with which it has received the most citations from scientific cooperation. According to the findings, Iran had cooperation with China with 12.3%, the United States with 12.1%, India with 6.8%, Egypt and Germany with 3.5%, Italy with 3.4%, Japan with 3.1%, South Korea with 3.3%, Sweden with 2.6%, and Canada with 2.5 % had the highest citations.

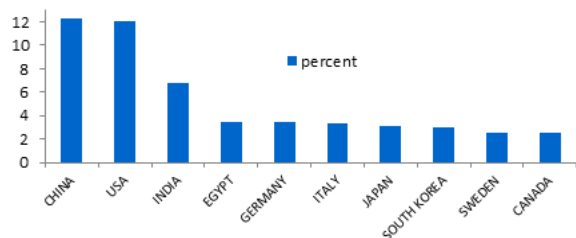


Fig 8. Countries of international scientific partnership with Iran with the most citations.

### DISCUSSION

The main objective of this research is to determine the status of Iranian research outputs in the field of radiopharmaceuticals aiming to represent the subject area of radiopharmaceuticals from different angles to help and provide information for the researchers as well as the related planners and policymakers in Iran. According to be the current study, Iran had the highest scientific production and the highest scientific rank in terms of citation, between the top two countries in the Middle East. The majority of Iran's scientific achievements has been in the last ten years, i.e., after implementing the comprehensive scientific plan for health.

Science production charts of the studied countries show that Iran's scientific productions in radiopharmaceuticals have a favorable position among Middle Eastern countries regarding the number of scientific productions, citations, and the growth time trend of citations. This growing trend appear to continue in the field of radiopharmaceuticals. One of the reasons for this being the interest and attention of the scientific community and policymakers to the country's upstream documents, especially the priority areas of the comprehensive scientific health map and, most importantly, the importance of prioritizing the production of radiopharmaceuticals in the face of sanctions. Nevertheless, Iran ranks second in term of citations, although due to global sanctions and sensitivity to Iran's nuclear science program, well-known scientific journals were refusing to accept articles submitted from Iran.

Cheshmyzdan et al. showed that Iran has the highest scientific rank among the priority fields of the comprehensive health map among the countries of Horizon 2025 [9]. In addition, the study of Dehnavieh et al. showed the growth trend of Iranian scientific products in the years after the preparation of a comprehensive scientific map of health [11].

Our findings demonstrated that more than half of the scientific products and citations belong to 10 organizations and universities. It seems necessary to encourage other organizations and academic centers to invest and be more active in the production of science, specifically in the field of radiopharmaceuticals to maintain and improve the scientific rank of the country. Several studies, including by Cheshmyzdan et al., emphasize that in many priority areas of the Comprehensive Health Map, a limited number of organizations have been active [12].

The findings also showed that domestic researchers contributed to almost two-thirds of Iran's scientific productions. A third of these works have been carried out in co-operation with researchers in other countries mostly USA. However, the findings indicated that Iran has had the most collaboration with the US and European researchers. At the same time, the highest number of citations was received from scientific partnerships with East Asian countries, especially China. Better political relation between Iran and Eastern countries, let to more research and scientific exchange with these countries. By better understanding the obstacles, and diligent planning specially in the field of radiopharmaceuticals, more significant improvement is achievable through cooperation with these countries.

### CONCLUSION

The main purpose and mission of the system of science, technology, and innovation in the field of health is to identify and solve the problems and pave

the way for research in order to maintain and improve the scientific level of the country in the region and in the world. In addition, the rate of realization of the comprehensive scientific plan of the country in the field of health is achieved by applying continuous monitoring and evaluation of the priority areas. Despite the growing trend of Iran in the production of science, from the years after the development of the scientific map in some fields, such as radiopharmaceuticals, citations have been decreasing over the years. To prevent further decreased and improve the level of scientific production specially in the field of radiopharmaceutical technology, our researcher require to have more interaction, scientific communication and cooperation with academic center in countries with advanced technology in health sciences, especially East Asian countries.

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