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Medical Science and Research in Iran

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Abstract

Background: During the last 3 decades, Iran has experienced a rapid population growth and at the same time the health of Iranian people has improved greatly. This achievement was mainly due to training and availability of health manpower, well organized public health network and medical science and research improvement. In this article, we aimed to report the relevant data about the medical science and research situation in Iran and compare them with other countries.

Methods: In this study, after reviewing science development and research indicators in medical sciences with participation of key stakeholders, we selected 3 main hybrid indexes consisting of "Research and Development (R&D) expenditures," "Personnel in Science and Technology sector" and "knowledge generation" for evaluation of medical science and research situation. Data was extracted from reliable databases.

Results: Over the past decade, Iran has achieved significant success in medical sciences and for the first time in 2015 based on Scopus index, Iran ranked first in the number of published scientific papers and number of citations in the region and among all Islamic countries. Also, 2% of the world's publications belong to Iran. Regarding innovation, the number of Iranian patents submitted to the United States Patent and Trademark Office (USPTO) was 3 and 43 in 2008 and 2013, respectively. In these years, the number of personnel in science and technology sectors including post graduate students, researchers and academic members in universities of medical sciences (UMSs) have increased. The female students in medical sciences field account for about two-thirds of all students. Also, women comprise about one-third of faculty members. Since 5 years ago, Iran has had growth in science and technology parks. These achievements were attained in spite of the fact that research spending in Iran was still very low (0.5% of gross domestic product [GDP]) due to economic hardships and sanctions.

Conclusion: Medical science and research development has been at least partially due to health technological development, training and availability of health manpower and improvement of overall health status in Iran compared to other Islamic countries.

Keywords: Iran, Medicine, Publications, Research, Science, Technology

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Introduction

In 2015, the United Nations General Assembly adopted a historic agenda for sustainable development till 2030.[1] In this level, science, technology and innovation (STI) are 3 main components for sustainability.[2] Also, it depends on putting the science at the core of the developmental national plan. To get an overview of the scientific status of a nation or region, it is necessary to use reliable integrated indicators.[3] Research and development (R&D) expenditures, the ratio of gross domestic expenditure on R&D (GERD) to gross domestic product (GDP), the number of personnel involved in science and technology sectors, number of scientific publications and citations, science and technology parks, patents, and number of research institutes or universities are some known indicators of scientific development.[4] Global expenditure on R&D has shown that investment in science will have benefits in the future and it has grown faster than the global economy.[5] Unfortunately, some research organizations in many low-income countries consume funds without any effective performance.[6] Thus, for better analysis of scientific development status in each country, we need to consider a hybrid index of scientific publication, technology utilization and innovation. From 2007 to 2014, the number of researchers, especially women researchers, and publications has increased by over 20% worldwide (http://unesdoc.unesco.org/images/0018/001899/189958e.pdf). At the same time, researchers were not only publishing more in international scientific journals but also co-authoring more with foreign investigators, and now the articles are becoming freely available.[7] Furthermore, universities and research institutes as global players are competing with each other to attract funds, professors and students.[8] Regarding technology, the main role of universities is closing the innovation gaps by creation and transfer of new knowledge.[9] In

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2013, almost one-third of the 2.6 million patents filed worldwide were from China.[10] However, basic research is extremely important for any future scientific discovery, but in order to solve developmental challenges, scientific discovery has shifted from basic research to 'relevant' or big science.[11] Computer networks and online interactions can facilitate this process.[12] The average number of Internet users per 100 populations in the world was 23.13 and 37.97 in 2008 and 2013, respectively. This figure was 10.24 and 31.4 in Iran.

In the past 2 decades, one of the most equitable and effective policies has been setting up open knowledge systems. This system facilitates solutions-oriented research and brings academics and non-academics together as knowledge stakeholders in science networks to solve problems.[13] This approach via technology access can cross boundaries between different disciplines.[14]

Considering the above, in this article, we will try to present relevant data about the medical science and research situation in Iran and compare them to neighboring countries as well as the more developed European and North American nations.

Materials and Methods

This is a cross-sectional study based on existing reports on national budget laws (http://shenasname.ir/1391-09-30-20-01-30/budjet/1393/2248-jadavel93.html), scientometrics data, evaluation results of research activities in Iranian universities of medical sciences[15] (UMSs) and research centers,[16] international organizations and so on from 2001 to 2015.

We selected 3 main hybrid medical science development and research indicators based on review literature with considering stakeholders' opinions as follows:

➢ R&D expenditures indicators:

- Total allocated budget to development science and technology
- The ratio of GERD to GDPThe public expenditure per tertiary student per capita

➢ Personnel in Science and Technology sector:

- Number of post graduate students
- Number of students graduating in medicine
- Number of female students in medical sciences
- Number of female academic member in medical sciences

➢ Knowledge generation:

- Number of scientific publications and citations
- Number of science and technology parks
- Number of patents
- Number of research institutes.

After gathering data on Iran and other countries, comparative tables and graphs were drawn.

In this study, all ethical principles have been considered.

Results

In this part, 3 main medical science and research development domains and their indicators are presented as follows:

Research and Development Expenditures

In 2014, the total allocated budget for Iranian development science and technology chapter was 27 652 792 million Rials, which was equivalent to 0.31% of the national budget. It should be noted that in developing countries, the main source of R&D budget is the governmental sector and the private sector has a very small role. In 2013, R&D expenditures covered by the governmental sector in the United States, Japan, Turkey and France were 30.79%, 17.3%, 25.55%, and 34.97%, respectively. The share of business enterprises in R&D expenditures as a source of funds in these countries was 59.13%, 75.48%, 48.87%, and 55.38%, respectively. In Iran, in 2009, the share of GERD financed by business enterprises and government sectors was 30.9% and 61.64%, respectively. While in 1998, in Iran, more than 99% of the R&D expenses were provided by the government.

Figure 1 shows an estimate of GERD as percentage of GDP in 2013 for some countries including Iran. Iran ranks much lower than the world average and only higher than Arab States. This percentage in 2007, 2009 and 2011 for Iran was 0.75, 0.31 and 0.31, respectively.

In 2011, in Iran, government outlay for R&D by major agency was 41 069 680 million Rials, of which more than 80% was allocated to universities and institutions affiliated to the Ministry of Science, Research and Technology, Ministry of Health and Medical Training, Ministry of Defense, Ministries of Industry and Agriculture, science and technology parks and institutions affiliated to the Presidency.

In 2013, the Iranian public expenditure on tertiary education was 0.84% of GDP (22.94% of total public expenditure on education). The public expenditure per

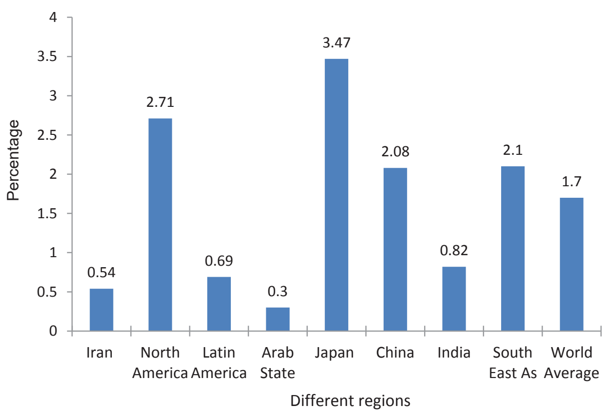

Figure 1. GERD as Percentage of GDP for Different Regions in the World, 2013.

tertiary student per capita in Iran was 14.77% of GDP. These percentages in the United State were 1.36 (26.11% of total public expenditure on education) and 20.08, respectively.

Personnel in Science and Technology Sector

The Iranian population in 2013 was 77.4 million that was equal to 1.1% of the world population. In 1998, a total of 1 200 000 individuals were studying for Bachelor, Master of Science (MS) and Doctor of Philosophy (PhD) degrees in governmental and Azad universities. This number was almost quadrupled in 2012 (Figure 2).

The number of MS and PhD students in 1998 was 23 303 and 3771, respectively. These figures rose to 454 978 and 60 900 in 2013. The increase in these segments is very considerable. The average annual increase for MS and PhD is almost 2900 and 3800, respectively. The majority of students pertain to social science and humanities (46%), technology and engineering (33.4%), basic science (7.2%), agriculture (6.3%) and medical sciences (1.3%).

In medicine, the number of students graduating as general practitioners (MD), doctor of pharmacy (pharmD), dentist (DMD) and specialist in medicine increased from 8800 in 1996 to 56,131 in 2014. In 1980, 2000 and 2013, the total number of practicing physicians (general and specialist) in Iran was 15 000, 60 000 and 115 000 respectively. Meanwhile, in 2014, there was one physician practicing for an average of 650 people (Figure 3). In 1980, this proportion was 1 to 2500 people. In 1978, about 6000 foreign physicians were employed by the governmental sector for medical practice and since 2000, this figure is zero.

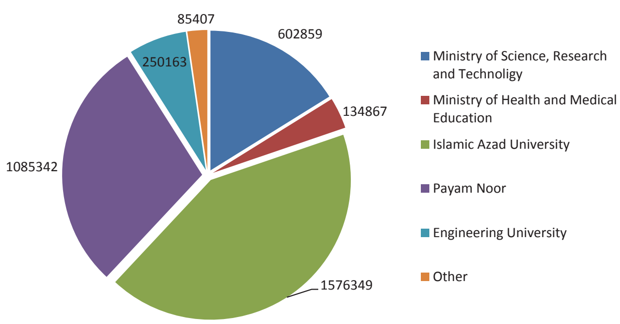

Figure 2. Number of Iranian Students in Different Universities in 2012.

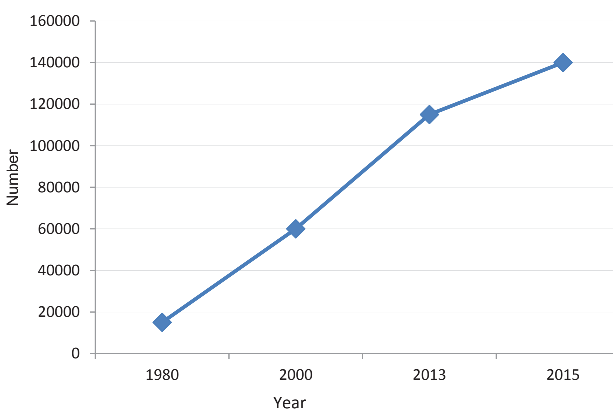

Figure 3. Number of Iranian Physicians (1980-2015).

Since 2010, the Ministry of Health and Medical Education (MOHME) has attempted to launch PhD by research courses in 188 research centers in 37 UMSs/ institutes and so far the number of students under training is 616.

In the field of medical sciences, the percent of female students was 42 in 1990 and this percentage rose to 68 in 2013 (Figure 4).

In 2013, there were 7.8 million researchers worldwide, and this number in Iran was 54,800 (equal to 0.7% of world researchers). The percent of total researchers from governmental and business enterprise sector was 33.6 and 15, respectively. Also, 51.5% of researchers were employed by universities and the average number of full-time university professors per million populations in the world and Iran was 1171 and almost 40, respectively.

In 2010, the share of Iranian women in research in natural science, engineering and technology, medical sciences, agricultural science and social science & humanities was 34.3%, 19.6%, 29.5%, 24.5%, and 25.5%, respectively.

In 2013, the number of researchers per million inhabitants in United States, Europe, and Asia was 1772, 2942 and 786, respectively.

The number of academic members in different universities and executive organizations in 2014 was 66314, and about 20% of them were affiliated to the MOHME (Figure 5).

In 2014, in governmental UMSs, the number of academic members and non-academic researchers was 14 500 and 1206, respectively. Figure 6 shows the number of academic members in UMS based on gender. The highest and lowest numbers of female faculty members pertained to assistant professors and professors, respectively. Women comprise about one third of faculty members, while the number of female students in medical sciences field is about two-thirds of all students.

Almost three-quarters of the faculty members in UMSs are tutors and assistant professors and there are only 918 full professors.

Figures 7 and 8 display the above-mentioned information regarding faculty members for type 1 UMSs.

The academic infrastructure has also expanded during the recent decade. The number of medical UMSs rose from 34 in 1996 to 52 in 2015. In 2001, the number of research centers was 26 and nowadays, this figure is 729.

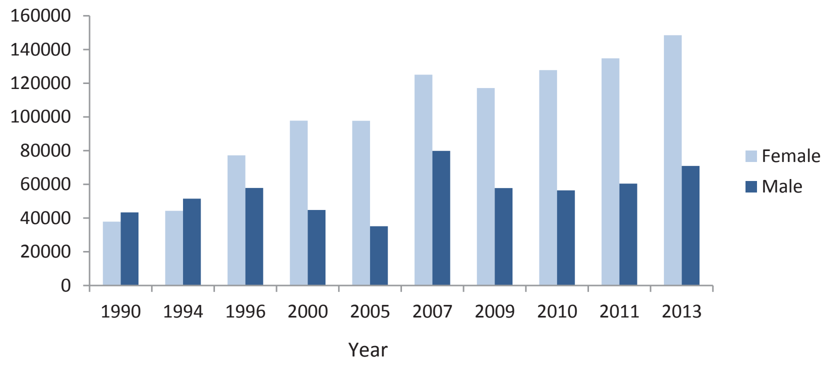

Figure 4. Number of Female and Male Students in Medical Sciences Field in Iran (1990–2013).

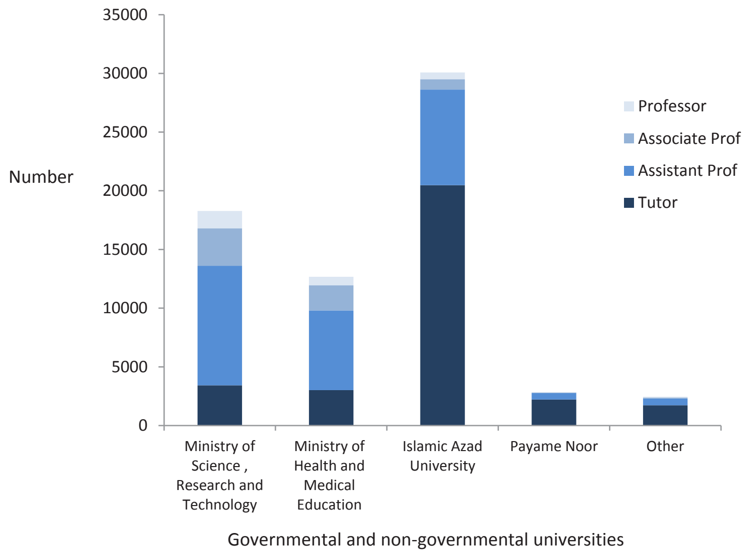

Figure 5. Proportion of Different Degrees of Academic Members in Iran - 2014.

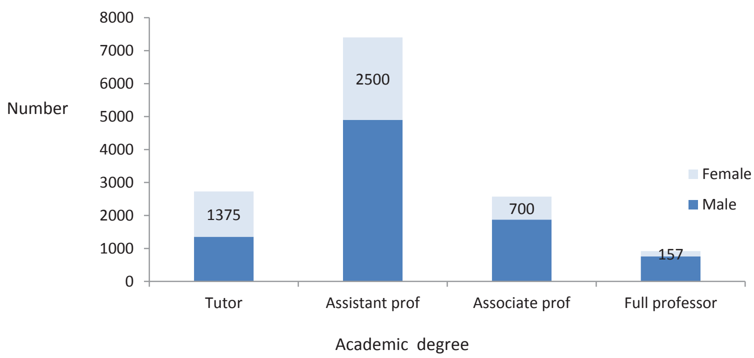

Figure 6. Number of Academic Members in Universities of Medical Sciences Based on Gender in Iran -2014

Knowledge Generation

Traditionally, knowledge generation was measured only by scientific publications, i.e. the number of articles published in scientific journals. Now, however, Science, Technology, and Innovation (STI) are the 3 main components of knowledge generation. Based on the United Nations Educational, Scientific and Cultural Organization (UNESCO) science report, the European Union (EU) still leads the world in publications (34%), followed by the United States with 25%. Chinese publications have nearly doubled over the past 5 years to 20% of the world total.

In 2014, Iran had 2% of world publication, and 23.5% of Iranian publications were with international co-authors. The percentages of international co-author publications in Africa, Europe, Americas, Asia and the whole world are 64.6, 42.1, 38.2, 26.1, and 24.9, respectively.

The Iranian publications per million inhabitants were

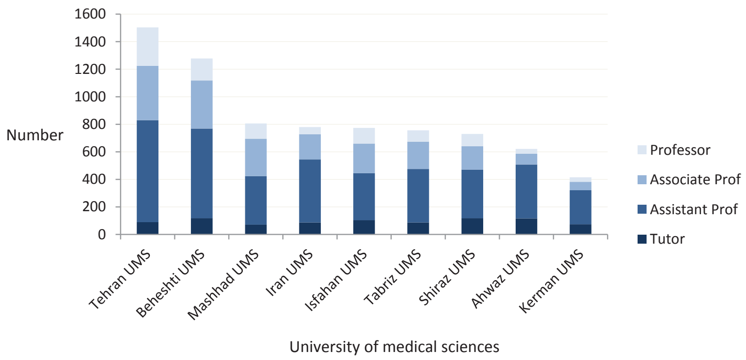

Figure 7. Proportion of Different Ranks of Faculty Members in Top 10 Universities of Medical Sciences

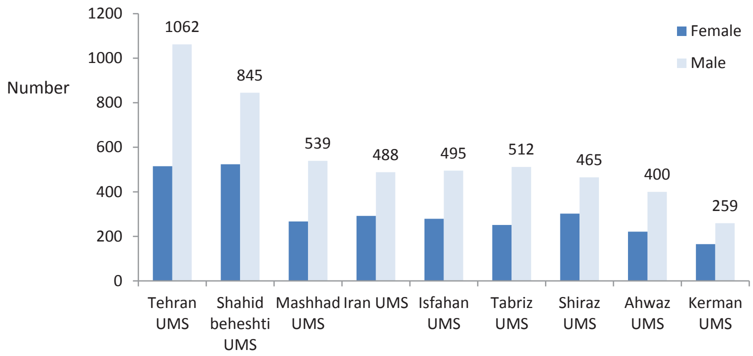

Figure 8. Number of Academic Members in Universities of Medical Sciences (Type 1) Based on gender-2014.

155 and 326 in 2008 and 2014, respectively. This figure was 263 and 311 in Turkey.

Figure 9 shows the different types of researches conducted by Iranian researchers.

Retrieved data from 2000 to 2014 show that in 2000, there were 1750 documents with Iran affiliation in Web of Science Core Collection. This figure rose to 2843 in 2002, 5161 in 2004, 9207 in 2006, 17 364 in 2008, 22 225 in 2010, 30 271 in 2012 and 31 619 in 2014 and almost one-fifth of documents were related to health and medicine. Figure 10 shows the types of Iranian documents in Web of Science Core Collection in 2015.

The top 10 research areas in this database are: engineering, chemistry, material science, physics, computer science, mathematics, science technology, energy fuels, mechanics and public environmental occupational health. During 2012–2015, total citations to scientific documents in medical and health fields in the Web of Science database were 30 803. This figure was 8637 between 2006 and 2010.

Analysis of queries about the term "Iran" in PubMed database shows that the number of articles increased

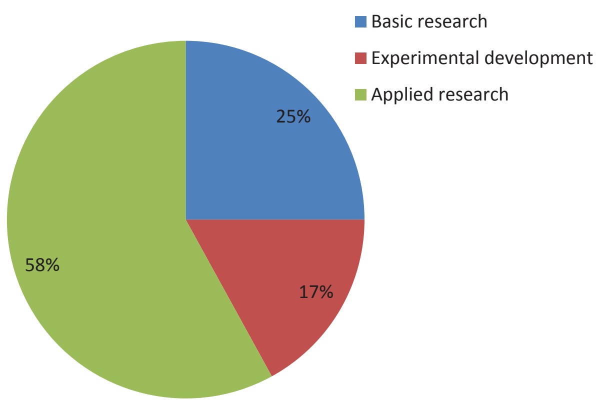

Figure 9. Types of Research Conducted by Iranian Researchers in 2015.

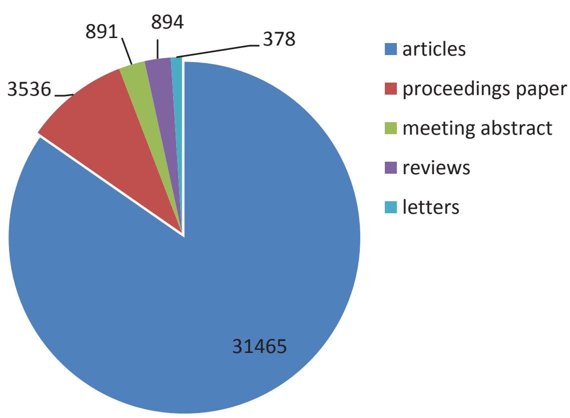

Figure 10. Types of Documents With Iran Affiliation in Web of Science Core Collection in 2015.

from 273 in 2000 to 14 511 in 2014 (more than 50-fold) (Figure 11).

In Scopus database, the number of published manuscripts with Iran affiliation in 2000, 2010 and 2014 were 1490, 22 312 and 39 125, respectively, of which almost 40% pertained to governmental UMS.

Figure 12 shows the top ten documents in Scopus in 2014 based on affiliation.

In Scopus database, total citations to all UMSs published articles were 106 575 in 2014, of which almost one-third pertained to Tehran UMS. In this time, the mean number of citations per paper was 6.88.

Almost 97% of articles published in Scopus from Iran are English, 2.5% in Persian and 0.5% in other languages.

The total projects in all UMS in 2013 were 14 421 and the number of published manuscript in Scopus in 2014 was 15 477 (Figure 13).

Figure 14 illustrates the situation of research in UMSs (type 1).

Regarding innovation, based on UNESCO science report, the number of Iranian patents submitted to

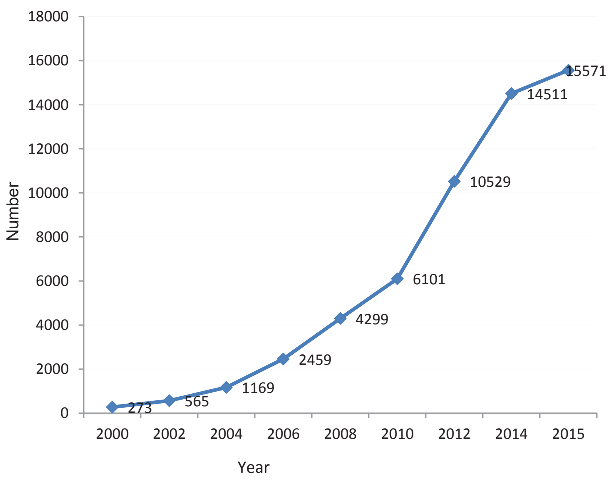

Figure 11. Number of Iranian Articles in PubMed (2000–2015).

United States Patent and Trademark Office (USPTO) in 2008 and 2013 was 3 and 43, respectively. This figure was 35 and 113 for Turkey, 3683 and 7287 for France, 848 and 3317 for India, and 79 968 and 139 139 for the United States. Since 5 years ago, Iran has had growth in science and technology parks (Table 1).

Discussion

There are some integrated indicators for assessment of main components of sustainable development such as R&D expenditures, S&T personnel sector and knowledge generation. Review of results shows that almost 0.5% of GDP is allocated to R&D in Iran. This percentage was 1.4 and 1.7 in world average in 2001 and 2013, respectively. During the past 2 decades in Iran, this percentage has increased only 0.1. There is a robust relationship between financial development and economic growth[17] and it seems that increasing the expenditure in R&D is necessary for developing countries.[18] Due to the main role of resource disparity in population in equity, the World Health Organization (WHO) convened Social Determinants of Health Committee (CSDH) to create commitment in order to achieve global justice.[19] Closing the gaps between developing and developed countries is the ideal goal.[20] The low GDP and GERD to GDP ratio in developing countries are the main limitations to world science development.[18]

Regarding S&T personnel sector, the results show that the percentage of the Iranian population to the world was equal to 1.1 in 2013, while this ratio was 0.7 for researchers. It means that the growth rate of S&T personnel sector is slower than the world average, although this rate is appropriate for Iran. In medicine, over the past 2 decades, the number of students graduating has increased seven-fold. Also, the number of female students has doubled and women comprise about one-third of faculty members. Moreover, the

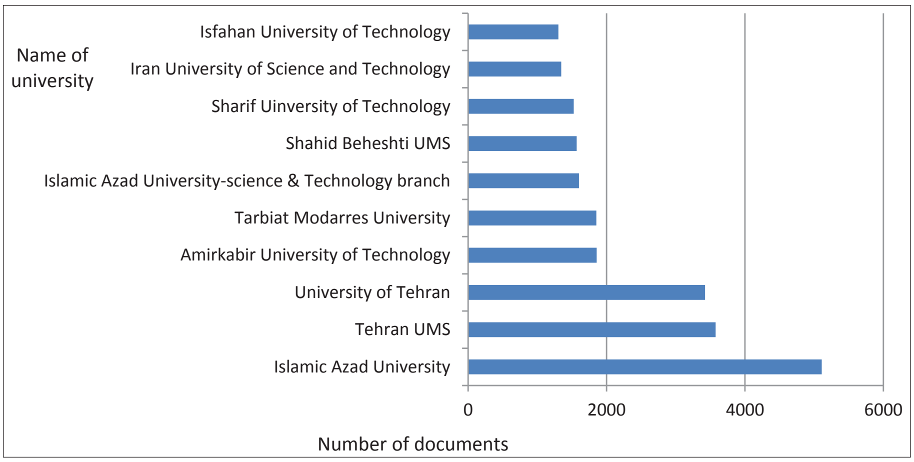

Figure 12. Top 10 Universities Based on Number of Documents in Scopus in 2014.

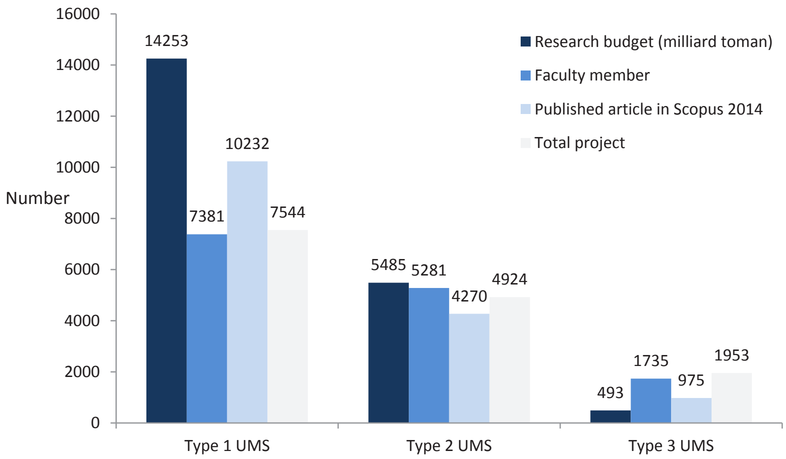

Figure 13. Research Situation in Universities of Medical Sciences in Iran.

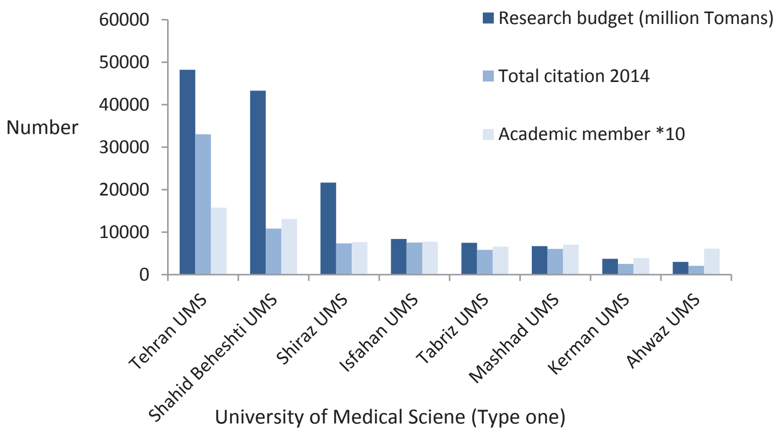

Figure 14. The Situation of Research in Universities of Medical Sciences - Type 1.

number of universities, research centers and institutes has increased significantly. It seems that Iran has taken appropriate action to strengthen the science structure. In the case of technology and innovation fields, establishments of science and technology parks, business incubators and so on are the main actions in Iran from 2010. For strengthening research infra structure, set up cohort projects, registry system, and comprehensive laboratories research are some of the important functions of MOHME in Iran. These projects facilitate the implementation of interventional programs for community health promotion. Regarding knowledge generation, in 2014, Iran had 2% of world publication with 0.7% of world researchers and 23.5% of Iranian publication were with international co-authors. It seems that Iran has a good rate in publishing scientific papers. In Iran, from 2000 to 2014, the number of articles indexed in Web of Science Core Collection, PubMed and Scopus has increased by 18, 53 and 26 folds, respectively. Also, the number of citations to Iranian articles has increased properly. This index shows that the articles have improved not only quantitatively, but also qualitatively. Nevertheless, the projects which can solve community problems are of great importance. Supporting demand-driven projects by government and private sectors can improve this problem. One of the

Table 1. Growth in Iran's Science and Technology Parks (2010–2013)

	2010	2011	2012	2013
Number of science and technology parks	28	31	33	33
Number of business incubator	98	113	131	146
Patents generated by science and technology parks	310	321	340	360
Knowledge based companies established in science and technology parks	2169	2518	3000	3400
Research personnel working in science and technology parks	16139	16542	19000	22000

most important actions of MOHME in improving the quality of papers was organizing scientific journals and continuous evaluation of them.

For a fundamental reform in research system, some short (S) and long (L) term management strategies will improve the quality of research as follows:

- Revising policy to pay more attention to quality rather than quantity such as high-quality publication (Q1) , impact factor, etc (S)
- Adopting a policy for qualitative evaluation in research centers in Iran based on peer review (S)
- Setting up mega projects (Persian cohort) to follow health related issues (L)
- Strengthening international cooperation with scientific research centers in the world (S)
- Establishment of granting body to support national projects (L)
- Setting up specialized courses consisting of Ph.D. by research, clinician scientist, post doctorate.

An analysis of scientific output from Iranian universities shows that in type 1 UMSs, paper per faculty member is more than one. The number of articles of Tehran UMS is more than the other UMSs and Tehran University in Scopus in 2014. Also among UMSs, Tehran has the most citations in Scopus in 2014.

It can be concluded that health research system in Iran is improving and the number of scientific papers, scientific journals, and research centers are completely appropriate. It is expected that Iran would pay greater attention to the quality of science, demand-driven projects to solve the community health problems.

Conflict of Interest Disclosures

The authors have no conflicts of interest.

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