

REVIEW ARTICLE

MEDICAL SCIENCE AND RESEARCH IN IRAN

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Abstract

The main indicators of the scientific status of a country are determined by research and development (R&D) expenditures, the ratio of gross domestic expenditure on R&D to gross domestic product, the personnel involved in the scientific research sector and finally by scientific publications and their ranking by well established scientific institutions. During the past two decades, Iran has enjoyed considerable expansion of trained individuals in the fields of medicine. The number of universities, faculty members and graduate students in different levels of medical sciences have increased manifold. There has been progress in public health and medical care delivery documented by reduced neonatal, infant and maternal mortality rate and increased life expectancy and curbing of infectious diseases. Despite the relative success in promoting health, medical care delivery and a surge of medical publication in Iran, contribution at the international level is not so promising. In order to achieve the desirable status in the world, performing high quality research programs and promotion of scientific publications are mandatory.

Keywords • Iran • medicine • R & D • education • publication • medline

Introduction

With the growing complexity of science and technology, reliable indicators for scientific development should be devised. Despite their many imperfections indicators of science and technology indicators are key elements of any global overview because they offer a means by which we may monitor and compare countries and regions of varying geographic size and socio-economic development. It should be recalled that each indicator represents one facet of the reality and indicators should be integrated to achieve an overview of the scientific status of a nation or region.¹

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 the science and research sector as well as scientific publications and their ranking by well established scientific institutions are some known indicators of scientific development. One other reliable indicator pertaining more to industrial

technology rather than medicine is the number of patents registered in the international patent systems, usually of North America and West Europe. Among the mentioned indicators, R&D expenditures and scientific output as publications seem to be the most clearly defined and least controversial parameters.^{1,2,3}

GERD to GDP ratio has classically been considered a valid proof of scientific progress, however, experience from the former Soviet Union, Eastern Europe and many third world countries show that this indicator should be regarded with caution. In fact, many research institutes and organizations in the aforementioned countries did, in fact, consume funds without creating productive knowledge and a developmental gap emerged between research and practical application of science.⁴ Thus, for a qualitative analysis of GERD expenditures a hybrid index of scientific publications, i.e. the number of articles published in scientific journals (science bibliometry) to R&D expenditure seems more favorable. Hereby, fundamental problems are also encountered: proper sets of journals representative of scientific activities are chosen by institutes located in the US and Western Europe.¹ The Science Citation Index (SCI) published by the

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Institute of Scientific Information (ISI) in Philadelphia USA in general and Current Contents, Excerpta Medica and Index Medicus with its online counterpart, the Medline, particularly in medicine are well known scientific quoting and indexing systems.⁴ These systems are, however, predominantly Anglo-Saxon and inevitably prone to bias in favor of articles originating in the US and Europe. Thus, contributions originating from the third world countries are underrepresented. Conceptual difficulties in defining the scientific personnel together with a lack of reliable qualitative measures hinder this indicator from becoming a valid indicator of scientific development.¹

By having the above-mentioned issues in mind, relevant data will be presented and comparisons will be made to the neighboring countries as well as to the more developed European and North American nations.

Current Situation

Research and development expenditures: Before 1996 research expenditures in the Iranian national budget were stipulated as “ Research and Investigation” and were dispersed among the allocated funds and other resources available to the ministries, organizations and foundations. This dispersion, which somehow hampered a clear estimation of R&D for medicine and other academic sectors was overcome in the 1996

national budget by incorporating a new and clear item; the so called “ Research Chapter”. In 1996, 0.47% of the national budget was allocated to R&D. These figures were 0.59% and 0.42% in the following two years.⁵ It should be mentioned that in developing countries the major source of funding for R&D comes from the governmental sector and the share of private sectors in procuring R&D resources is negligible. For instance, in the 80s less than a half (e.g. 45.9% in 1988) of R&D expenditures in the United States, a fifth (e.g. 19.9% in 1988) in Japan, slightly more than a half (e.g. 51.9% in 1987) in France and about a third (e.g. 36.5% in 1989) in the United Kingdom were funded by the governmental sector.⁶ This is in sharp contrast to the situation in developing countries where most or even all of the expenditures are supplied by the government. In India around 90% of the R&D expenses are afforded by the government and in Iran this amount sums to more than 99%.⁷

An estimate of GERD as a percentage of GDP in the mid 90s for some countries including Iran is shown in figure 1. Iran ranks much lower than Japan, North America, and Western Europe, lagging even behind the world average. Figures are similar for Arab states and China, however not much lower than India and Central Asia.

Annually, approximately a fifth of the R&D resources are allocated to the academic sector in Iran. During the past decade sums as high 0.22% in

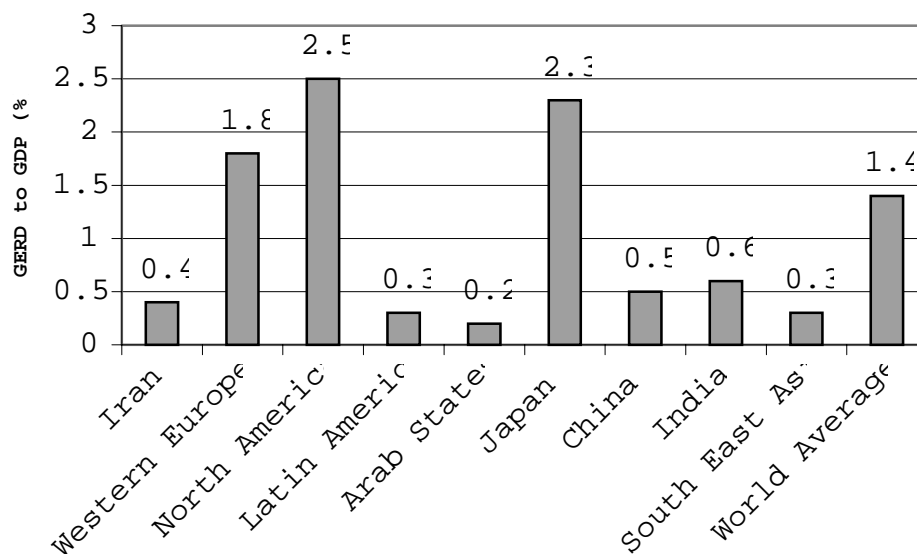


Fig 1. GERD as a Percentage of GDP for Different Regions in the World, 1994

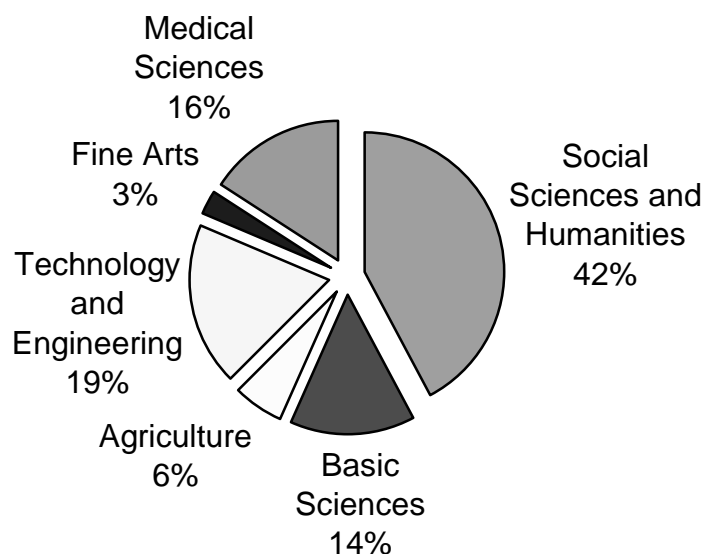


Fig. 2. Proportion of Iranian Students in Different Fields of Study in 1997-98

1991 to as low as 0.11% of the national budget in 1993 and 1996 were assigned to research in the universities and research institutes.⁵ Sudden and probably deleterious fluctuations reaching up to 100% in consecutive years, merits notice and concern. The ratio of academic sector R&D to the total R&D seems comparable to many other industrialized countries including Japan, Germany, France and the United States.

The Iranian R&D budget does not distinguish medical research apart from other fields. Estimation of the research expenditures made in the health and medical sector has its own problems. Some of the funds are allocated as part of social research in the annual national budget and a share of academic R&D resources is also assigned to the field of medicine. A rough estimate may be acquired by summing up expenditures made by medical universities, medical research centers and the Ministry of Health and Medical Education (MHME). Some other ministries also provide resources for medical research. Over the past decade, as low as 0.020% of the national budget in 1995 to 0.027% in 1998 has been provided for R&D in medicine.⁵ In 1997, about 50 billion Rials were invested in research in medicine. These figures show that the health care and medical sector consume only about 5% of the annual investments in R&D. Agriculture / natural resources and the energy sector are the main consumers of R&D investments receiving about 40% and 25% of the total investment, respectively.⁵

When converted to US currency equivalents,

R&D expenditures in medicine are of course insignificant: The total R&D in medicine for 1998 turned out to be something around \$10,000,000.⁸

Meanwhile, the expenditure for higher education was less than 0.5% of the annual governmental budget in 1982. This figure increased to more than 3.5% in 1996. The higher education received less than 0.5% of GNP in 1983 and rose to 1% in 1996.

Personnel in the S&T sector: Estimating the number of scientific personnel has its own inaccuracies. Reliable statistics are usually missing in third world countries and the true definition of "scientific staff" is controversial. But a cursory analysis as to the number of graduates from universities, as an indicator of scientific development, shows that the gap between Iran and developed countries is less pronounced. The number of graduate and undergraduate students has increased several times during the past decade. After a period of stagnation in the early 80s, there was a period of expansion in the higher education infrastructure and a concomitant multiplication of faculty members and trainees.^{9,10}

In 1978 a total of 175,675 individuals were studying as BA/BSc, MA/MS, PD (professional doctorate) and PhD. This figure rose to 625,380 in 1998. If the number of students studying at the Islamic Azad University (610,000) were added to this amount the total number of students studying in higher education would surpass 1,200,000.⁸ The majority of students belong to social sciences and humanities (42.3%), technology and engineering (19.0%), medical and health sciences (15.7%) and

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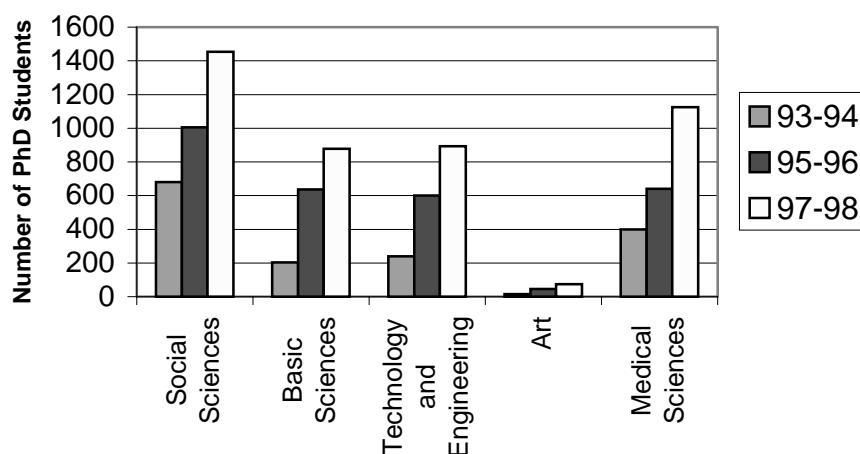


Fig 3. PhD Students Studying in Different Fields in Iran

basic sciences (14.3%). Agriculture and fine arts make up the remainder (Fig. 2). In the non-medical fields, the majority of the students are in the bachelor levels while MS and PhD degrees are less abundant. The distribution of students in various degrees and fields changes if figures belonging to the Islamic Azad University are added. This university educates almost half of the Iranian students in higher education with some 61% of its students enrolled in the field of humanities and social sciences. Only 5% of the students of the Islamic Azad University are enrolled in the fields of health and medical sciences. This is probably due the fact that this university invests less in resource consuming fields.⁸ From 1993 to 1999 there was a constant rise in the number of post-graduate students in non-medical fields. In fact, the number of PhD students remained almost the same from 1978 to 1993, while the number of MS and PhD students in 1993 were 17,171 and 1,253 respectively. These figures rose to 23,303 and

3,771 in 1998. The increase in the PhD segment is considerable and displays an average annual increase of 30%(Fig. 3).¹¹

In medicine the number of students graduating as general practitioners (MD), doctor of pharmacy (PharmD), dentist (DMD) and specialist in medical laboratory sciences increased from 1,138 in 1980 to about 8,800 in 1996. This almost eight fold increase is mainly due to a sharp increase in the recent 5 years.¹⁰ The number of graduating physicians is depicted in figure 4. A simultaneous rise in the number of physicians graduating as specialists or PhD during these years is evident. Figure 5 displays the number of students under training in health and medicine in different levels.^{10,12} Interestingly the general practitioner, doctor of pharmacy and dentist component is the most abundant. This shows an inclination toward training in practical and clinical fields of medicine. PhD students comprise about one percent of the total. A significant portion of the individuals in the

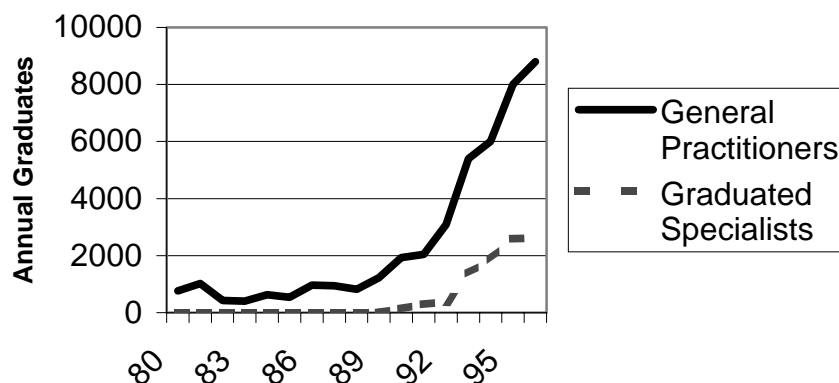


Fig 4. Medical Graduation Growth in Recent Years in Iran

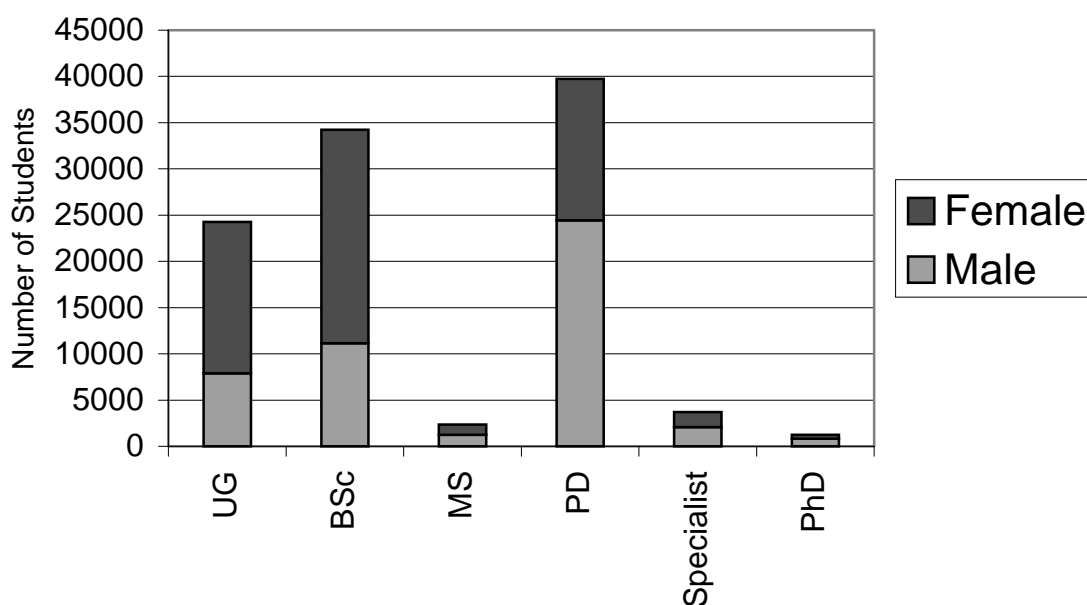


Fig 5. Students Training in Health and Medicine in Different Levels (1998).

UG: Under-graduate, BSc: Bachelor in Science, MS: Master in Science, PD: Professional Doctorate

undergraduate and bachelor degree are training in the fields relevant to medical care rather than research. This vigorous investment in training and education in the applied medicine, although might divest the science and research sector of potential recruits, but has been certainly much beneficial in improving health and medical care standards.

In 1980 the total number of practicing physicians in Iran was about 15,000. This number has almost exceeded 60,000 in the recent years. Mean while in 1980 there was one physician practicing for an average of 2,500 people. During the following years probably due to emigration and other social

factors this ratio even worsened and hit the rock bottom of 1 physician per 3,000 people. But less than 10 years after Iran's health system is enjoying a third world ideal of 1 physician for 1,000 people (Fig. 6). Besides there were about 6,000 foreign physicians employed by the government for medical practice in Iran in 1978 but nowadays, this figure is almost zero.^{9,10,12}

One interesting change is the relative increase in the number of female students and graduates in country's medical system. Women comprise about 54% of the students in the health and medical fields. Although the female dominance is more

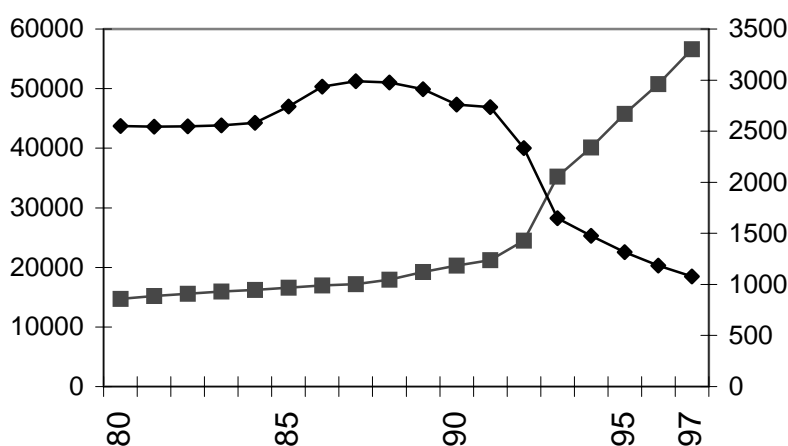


Fig 6. Number of Iranian Physicians and Physician per Population

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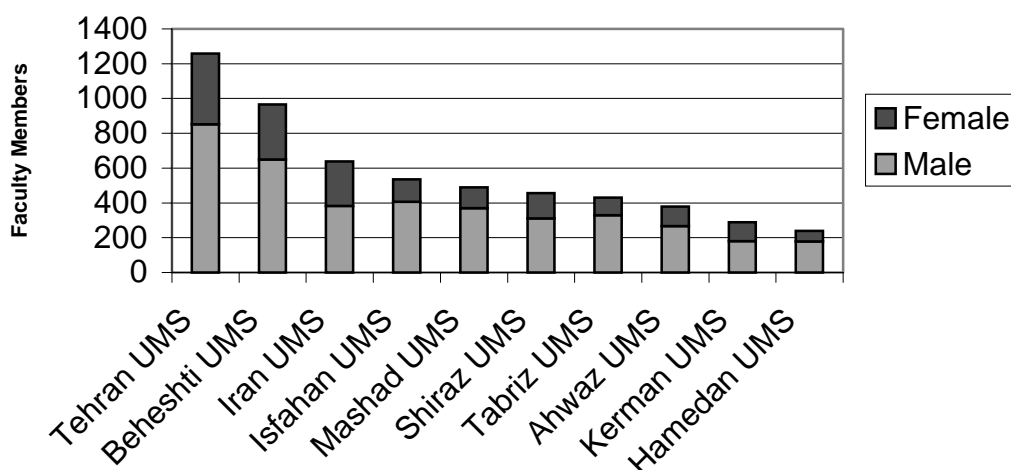


Fig 7. Top Ten in Iranian Medical Schools Regarding Number of Faculty Members

pronounced in undergraduate and bachelor degree levels, a considerable proportion of students studying medicine, pharmacy and dentistry are women (Fig. 5). This dominance is not restricted to large and industrialized cities, smaller cities with population less than 500,000 may also show an even greater female to male student ratio. This is in line with the increasing literacy rate of women in Iran.¹⁰

The number of faculty members in all fields including medicine, humanities and social sciences, technology and engineering, basic sciences and fine arts, was 8,249 in 1978. This figure rose to 25391 in 1998. Due to the sharp rise in the number of students this apparent manifold increase was later blunted and the staff/student ratio (SSR) declined from 1:21 in 1978 to 1:25 in

1998. According to 1999 statistics, 8,625 faculty members were employed in the health and medical education branches of the governmental universities.^{8,13} Additional 1,158 members were affiliated to non-governmental universities including the Islamic Azad University and some training centers belonging to the military forces and special foundations.⁸ These figures show that the ratio of faculty staff to student in the medical and health sciences is less than 1 to 12. A closer look at the make-up of the faculty members show that they are mostly in younger ages and currently employed as tutor or assistant professor. These figures are 2,855 and 4,810 out of 8,625 respectively. Only 227 are full professors. About 1/3 and 3/4 of the faculty members are younger than 40 and 50 years of age respectively.¹⁰ Women

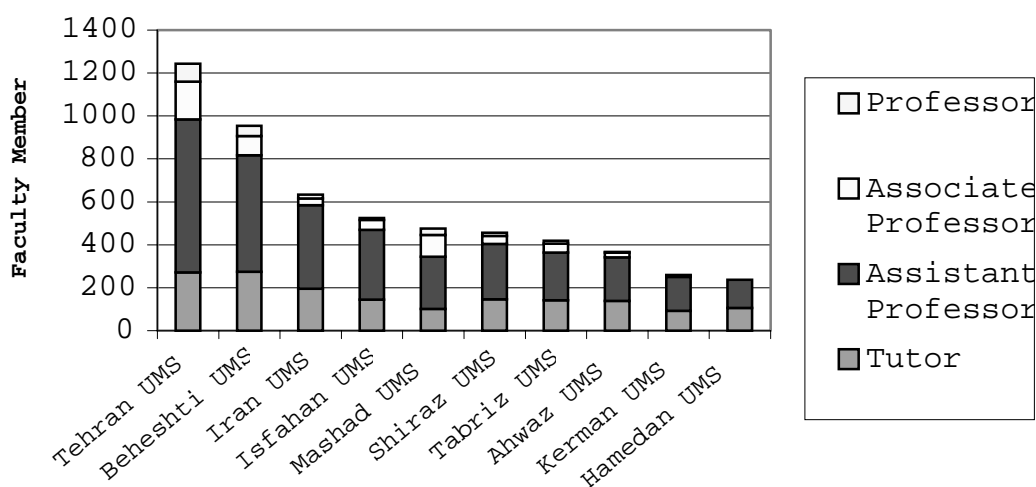


Fig 8. The Proportion of Different Ranks of Faculty Members

comprise about 1/3 of the faculty members. The above-mentioned aspects for the top ten ranking universities (considering number of faculty members) are displayed in figures 7 and 8. It is apparent that these ratios are quite similar and even some forerunners of Iranian medical education such as Tehran University of Medical Sciences have a similar make up as newly established universities. There has been a recent rise and turn over in faculty staff, which is manifested, in the high dominance of assistant professorship. In the humanities and social sciences about 5,000 faculty members are employed. These figures were 3,660 and 3,304 for the basic sciences and technology and engineering in 1998 respectively. Thus SSR for the humanities sector is approximately 1:52, while it is 1:36 in the technology and engineering sector, 1:26 in the basic sciences and 1:40 in arts.^{8,10,13}

The academic infrastructure has also expanded during the recent decade. The number of medical schools was 7 in 1970 and 14 in 1979. This number rose to 28 and 34 in 1990 and 1996 respectively. Schools of pharmacy and dentistry were 3 in 1970. In 1996, 9 pharmacy and 12 dentistry schools were functioning in Iran. Before 1978 Iran had less than seven research centers active in the country, nowadays this figure has passed 26.^{8,10,14}

Long-distance learning has been added to the Iranian higher education since 1987. Currently about 120 centers affiliated to the Iranian Open University (*Payam Nour*) are available and more than 130,000 people, half of whom are women, are studying in such centers.⁸

Lack of a reliable definition on research personnel in science and technology impedes us from providing meaningful figures. In one official communication, the Iranian Ministry of Health and Medical Education claimed that 10,122 research staffs are present in different sectors of medicine in the year 2000. This report does not offer the criteria for research staff; hence the figures should be evaluated cautiously.¹⁵

Publication as a monitor of scientific activity: Scientific activity is traditionally measured by the production of scientific publications, i.e. the number of articles published in scientific journals. There are various systems of article citation in the world. One reliable and widely recognized database for citation is the Science Citation Index (SCI) established by the Institute for Scientific Information (ISI) in

Philadelphia, USA.¹ The ISI database covers over 16,000 international journals, books, and proceedings in pure science, social sciences, as well as arts and humanities, and indexes complete bibliographic data, cited references, and author abstracts for every journal item it includes.¹⁶ In medicine, the Index Medicus with its online counterpart Medline seems to be a reliable system of indexing and citation. In this article, we have chosen the SCI for general scientific publication and the Medline as the means of assessing the output in medicine.¹⁷ Retrieved data from 1993 to 1998 show that in 1993 there were 299 articles by Iranian scientists cited in the SCI. This figure rose to 368 in 1994, 463 in 1995, 582 in 1996, 667 in 1997 and 1023 in 1998. In other words except for the year 1998, which showed a 50% increase in citations, there has been an annual 25% growth in indexed scientific output during the recent years. A closer look at the data reveals that almost 95% of the articles belong to natural sciences whereas citations in arts, humanities and social sciences comprise less than 5% of the indexed output. Considering the large number of faculty staff together with PhD and MS students especially in the latter sector, such a low output merits notice.¹³

For assessing the publications in medicine, the Medline was used. Medline is the National Library of Medicine's (NLM) premier bibliographic database covering the fields of medicine, nursing, dentistry, veterinary medicine, health care system, and the preclinical sciences. More than 10 million records are available and more than 30,000 are added each month. About 2 millions of Medline citations belong to the period of 1966 to 1974. Afterwards, there have been around 2.5 million citations added in the following 10 years. In the late 80s, citations increased to 400,000 per year. Currently, about 450,000 new entries are made each year (Fig. 9). It contains bibliographic citations (e.g., author, title, and journal reference) and author abstracts from over 3,900 biomedical journals published in the United States and 70 foreign countries.¹⁷ The Medline does not offer statistics about nations thus these data should be retrieved indirectly (P. Tillman, personal communication).

Queries about the term "Iran" were made which yielded near 2300 entries of which about a half were related to the articles originating from Iran. The records were observed and analyzed from different aspects. Also queries about the citations from other countries were also made. In this

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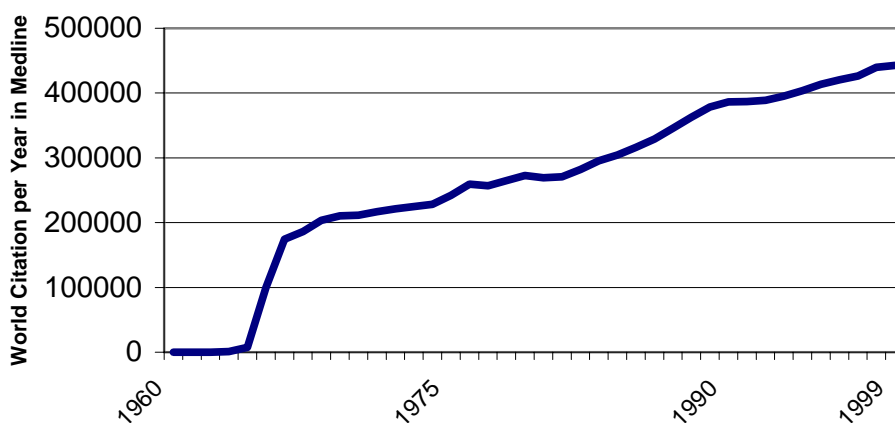


Fig 9. Annual World Citation in the Medline

regard, different spellings of the country's name in different languages were looked for. To limit the results to articles originating from the desired country, the affiliation [AD] option of the Medline was activated. These results were analyzed according to the year of publication, language of the article and country of origin of the journal in which the article was published. A list of journals from the countries in the region was prepared separately and the number of citations in these journals was also noted. Using Boolean operations of the search engines, the overlapping instances were deleted. It should be pointed out that the results are only approximations and definite figures are not available.

The results show that the growth rate of

citations from Iran was similar to the industrialized countries and accounted for about 0.01% of the total citations. After a period of stagnation in the early 80s the number of cited articles show an increasing trend (Fig. 10). While Iran had only 12 articles cited in 1980, this figure increased to 58 in 1990 and to 191 in 1999. By early September about 200 articles were cited in the year 2000. Although the trend is promising for Iran, it lags, however, far behind her neighbors. Turkey, Egypt and Saudi Arabia have far more articles cited in the Medline. Even smaller countries such as Kuwait are doing better. A closer look at the results reveals that these countries secured a rapid surge during the late 80s. Moreover, these countries have indigenous journals, which are cited in the Medline

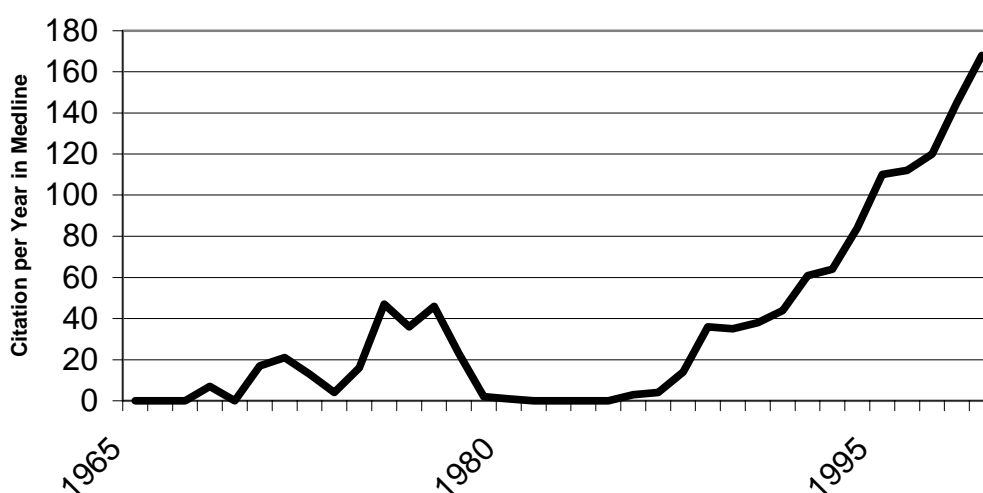


Fig 10. Annual Citation Rate in the Medline from I.R. Iran.

The Peak before 1980 is Mainly Due to Citation in Local Journals Indexed in the Medline

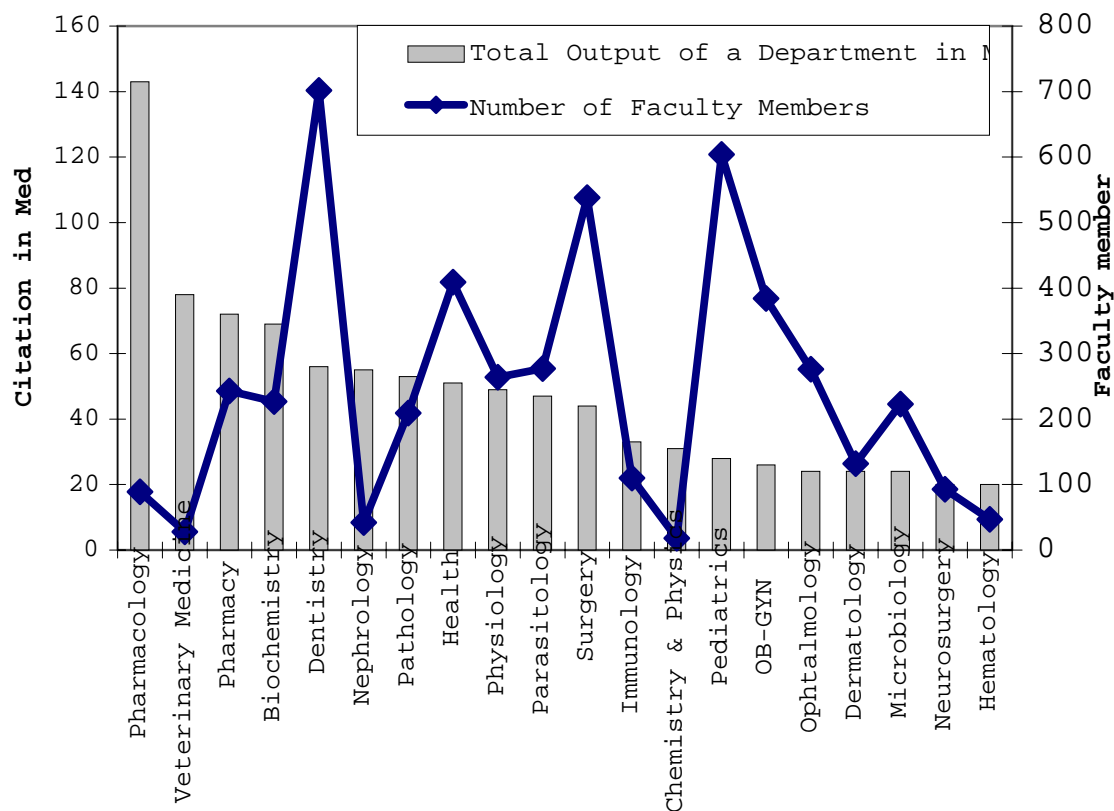


Fig 11. Department Staff and its Contribution to Medline

the Medline. An overview on the fields of cited articles in the Medline reveal that about one fifth belongs to pharmacology and pharmacy. Veterinary medicine, biochemistry and dentistry comprise other high-ranking fields, while internal

medicine, surgery and pediatrics are not so prominent (Fig. 11). If the scientific output is compared with the number of faculty staff in the relevant fields a strong mismatch appears. The lower output of the staff in clinical medicine

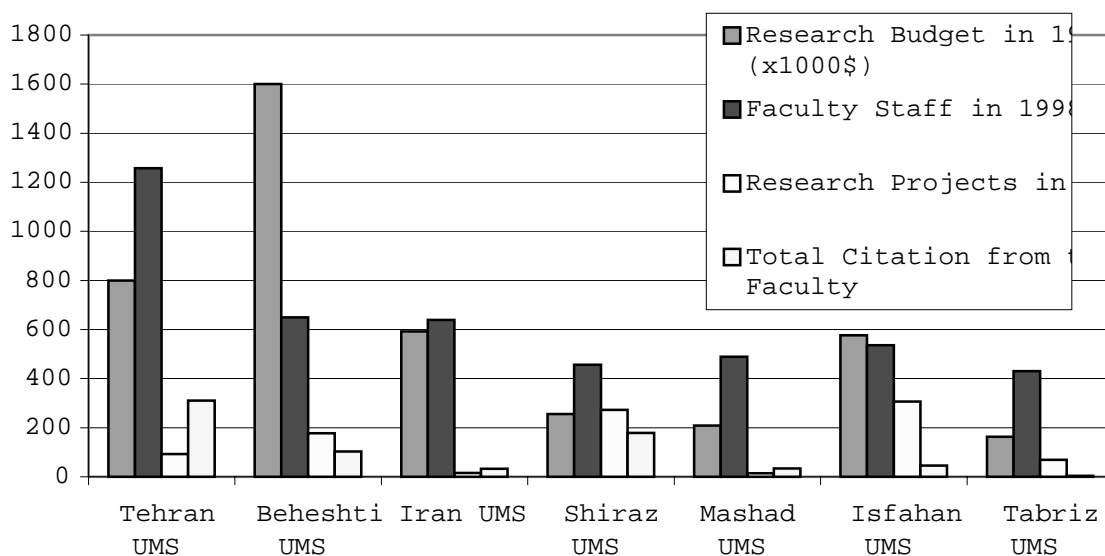


Fig 12. The Situation of Research in Seven Medical Schools

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probably reflects a treatment-oriented function while higher output in pharmacology despite relatively lower staff number is indicative of their more research-oriented settings.

More than two thirds of cited articles from Iran are published in journals belonging to the United States and England. Dutch and German journals also publish about a fifth of the articles. The articles, even those published in non-English speaking nations are mostly in English. Publication in French and German has been infrequent.

Tehran University of Medical Sciences (UMS) with more than 300 and Shiraz UMS with about 180 articles are the leading universities according to the number of citations. Beheshti UMS and Isfahan UMS are apparently the next. A comparison of the number of faculty members, research budget and number of research projects to the total citations show that there is a weak correlation among them. Iran UMS and Tabriz UMS, although major medical universities in the country are among the less active ones in worldwide publication (Fig. 12).

Contrary to the relative paucity of publications outside, there has been a marked increase in the number of articles and journals published inside. Currently there are more than 67 medical journals published in the country, none indexed in the Medline. This figure was less than 8 about two decades ago (Fig. 13). In 1979 less than 100 medical articles were published in local journals.¹⁸ This figure increased to 400 in 1985 and around

1,300 in 1997. In 1999 more than 1,850 articles appeared in Iranian journals. Thus every year only less than 7% of Iranian scientific output as publication find their way to international citation, not fulfilling international standards probably a reason.¹⁵

Discussion

Iran with about 0.4% of her GDP allocated to R&D ranks far behind industrialized societies and even the world average of 1.4%, though still in the acceptable limits among the third world standards. Two decades ago less than 0.1% of the GDP was allocated to R&D thus the fourfold increase seems promising. Latin America and Arab states have similar or even lower ratios. Increasing the expenditures in R&D seems mandatory for developing countries. Closing the knowledge gaps between the third world countries and industrial countries is not easy. Developing countries seem to be pursuing a moving target. In fact, disparities in allocating resources for creating knowledge exceed even disparities in income. Besides, attempts to increase GDP, an existing problem for developing countries, will lead to an increase in the net GERD. The low GDP and GERD to GDP ratio are the main factors for their limited contribution to the world science, altogether probably not the sole factors. When considering regional states with probably smaller net GERD but higher scientific output in terms of publication, inconsistencies

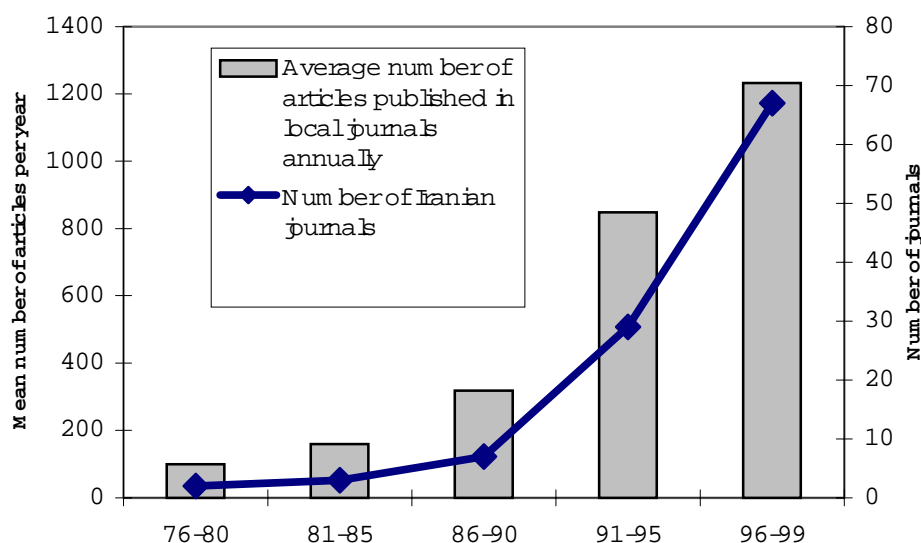


Fig 13. Number of Articles and Medical Journals Published in Iran

become apparent. Iran has expanded her universities and the number of faculty members and students has grown manifold. Besides the rapidly increasing number of articles published in non-cited journals show that science production does in fact take place but due to various factors the international contribution is sparse. One determining factor is certainly the lower quality of indigenous publications.

This prioritizing of improving health and medical care led to a partial negligence in the production of pure science. Instead, there has been quite a success in improving all health indices including infant mortality rate and life expectancy. Neonatal and infant mortality rates were 25 per 1,000 live birth and 45 per 1,000 live births in 1989 respectively. These figures plummeted to 20 per 1,000 and 33 per 1,000 of live births in 1994. The neonatal mortality rate was 97 in 1000 two decades ago. Maternal mortality rate was 237 and 90 in 100,000 live births in 1979 and 1989 respectively. This figure improved to 54 per 100,000 live births in 1993. Currently it is 33 in 100,000 live births. In 1994 more than 55% of women had access to and used some kind of modern contraceptive methods. This figure is considerably higher than many neighboring and regional nations. In fact, the national family planning and population control has been quite successful. The population growth rate being 3.9% two decades ago, is currently down to 1.5%. Immunization programs have also witnessed success in Iran. In 1984 infant immunization for polio, tuberculosis (BCG), measles and DPT (diphtheria, tetanus and pertussis) were 34%, 10%, 28% and 3% respectively. These rates increased to 97%, 99%, 95% and 97% in 1995 respectively. Maternal vaccination rate against tetanus was 3.8% in 1984 and increased to 82% in 1995. These sharp rises were in part due to nation wide mobilization campaigns performed during the recent years. Iran has also launched several national programs since 1991, including total elimination of neonatal tetanus and poliomyelitis and control of measles.¹² Major progress has been made in diminishing diarrhea in children under 5 years of age, acute respiratory infections in neonates, iron deficiency anemia and iodine deficiency in all age groups.^{19,20}

According to the 1996 statistics around 100,000 hospital beds were available nation-wide. This makes 1.63 hospital beds for every 1,000 population. This figure is far away from 4 hospital beds per 1,000 recommended for the East

Mediterranean Region. According to estimations, more than 140,000 beds are required to reach this standard.¹² Despite the shortage in the number of hospital beds due to accommodating and converting many non-educational hospitals to academic and tutorial hospitals the teaching-bed to student ration doubled in the last decade and reached 2.08 in 1994.¹⁸

Apparently most of the resources and intellectual manpower has shifted to the health and medical care. This shift has led to improving health standards in Iran and the profile of disease and health has changed from that resembling a third world nation to that of an industrialized society. Cardiovascular and cerebrovascular diseases and cancer have become the major causes of death in Iran and comprise more than 80% of mortalities, while major infectious and parasitic diseases have decreased considerably.⁸ It seems that with relative manpower saturation of this sector and change in health and medical needs, resources should now be made available for improving scientific standards. Changes in policies and rendering more weight to research and qualitative boost to scientific knowledge are mandatory. Even with current macro- policies some issues seem noteworthy. An important point is that due to lack of proper competition and correct supervision over the research programs, the transformation of results to publication is impeded. Besides, the current academic policies do not offer additional credit for international publication, reducing motivation for improving quality. Apparently science is being produced in Iran but it does not reach the standard necessary for incorporation into world knowledge. The expanded scientific infrastructure in Iran and the abundance or even a surplus of educated personnel offers a good opportunity for flourishing in knowledge production. In addition to fundamental reforms in the scientific system, some short-term management will improve the Iranian share in the production of science:

-Revising policies in order to offer more credit to the quality rather than the sheer quantity. Promotional systems should consider impact factor of the articles and citation index as the prime factor in output evaluation.

-Instead of continuously increasing the number of journals published in Iran, they should be conglomerated and enriched in order to gain international acceptance and indexing. Unfortunately the rapid multiplication of indigenous journals has led to depletion in

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content and delay in timely publication. Some journals should be demoted in favor of the more flourishing ones. The Iranian academic system should dedicate some of its resources for upgrading a few journals for securing citation in the indexing systems. Without such journals, in the era of expanding systems of knowledge transfer contributions by Iranian scientists would diminish rapidly. The concept of “publish or perish” seems to be transformed to “index or perish”. Special credit should be given to publishing in English.

-Collaboration with international research centers and renowned scientists can be a major factor in improving the quality of scientific output. The relative academic seclusion of Iran should end and discourse and mutual collaboration with other scientific centers of the world should be encouraged. More than 90% of the articles cited from Iran in the Medline have no authors from abroad. This is in contrast to the current trends in appraisal of multi-center, multinational collaborations.

-Scientific journalism should be promoted and pertinent staff should be trained in the field. Some surveys indicate that technical obstacles in translating, editing, and formatting impede Iranian authors from preparing articles for international audience. Centers such as the Academies of Sciences and the Research Deputies of the relevant ministries should provide resources and staff with journalistic expertise for improving the quality of local articles. These departments and organizations may sponsor journals with the primary goal of promoting Iranian scientific accomplishments in the world. The editorial board in these journals should have wide geographical distribution with more emphasis on states with conditions similar to Iran. The *Archives of Iranian Medicine* published by the Academy of Medical Sciences of Iran and *The Iranian Journal of Medical Sciences* published by the Shiraz UMS are in line with such policies.

-An analysis of scientific output from the Iranian universities reveals that the number of scientific staff or budget has no strict correlation with science production in Iran. Faculty policies and management capabilities appear to be more important issues. The lower output of some departments and universities should be scrutinized and positive feedback should be offered to more productive sectors.

The relative success of the Shiraz UMS in international publishing is perhaps due to her background and traditional policies of stressing on the English publication and contact with the outside world.

-One other policy can be filling the present gaps and niches in world science. Every day hundreds of medical journals are published and distributed worldwide. To seek an appropriate position, third world countries must contribute to the current literature; and should offer something new. Nevertheless, with restricted resources and limited research budgets, competing in fields of research that are very well funded and are already under intensive research by scientists working in industrialized countries, will be fighting on an uphill battle, and duplicity of such research is both futile and a waste of limited resources. Research on locally prevalent diseases, however, seems to be a more reasonable approach. The third world countries, with hundreds of thousands of physicians monitoring the majority of the world's population, are an important potential source of scientific observations and research. Taking advantage of endemic and indigenous states will compensate somehow for the limited resources in third world countries. Stress should be made on research topics unique to third world countries and avoiding duplicity and re-exportation of knowledge to the world.²¹

-Research institutes and centers are proper facilities for science production. Pasteur Institute, Gastroenterology Research Center, Endocrine Research Center and Tuberculosis and Lung Disease Research Centers have been successful in science production and international publication. Policies for expanding specialty units should be stressed.

It can be concluded that Iranian scientific status is improving and after a period of stagnation is slowly catching up. A mismatch between Iran's current potentials and her scientific contribution is a reality. It is expected that Iran would offer more to international knowledge and that the present retardation could be overcome by careful and well-designed manipulations.

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