

## Original Article

# Critical Assessment of Progress of Medical Sciences in Iran and Turkey: The Way Developing Countries with Limited Resources Should Make Effective Contributions to the Production of Science

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## Abstract

**Background:** Scientific progress is an important indicator for the social and economic developments of any country. According to various reports, worldwide, Iran has the most growth in the field of science due to a high increase in the numbers of publications during the past decade. The aim of this study is to assess not only the quantity, but also the quality of publications of indexed Iranian journals and compare them to Turkey, as an Islamic neighboring country, in addition to the contributions of these two countries to our Knowledge.

A number of international journals with high impact factors were selected to assess the contributions of scientists from Iran and Turkey to the medical sciences.

**Methods:** English medical journals from Iran and Turkey indexed by the ISI Web of Sciences with known impact factors (IF) announced at the beginning of 2010 were included for evaluation. We calculated the number of all articles published from the beginning of 2007 until the October 2010, the number of total citations, and citations from authors outside both countries for each journal. In addition, we selected all articles cited at least six times by authors outside of both countries and discussed their content with regard to originality and novelty, as well as their contributions to current knowledge. Furthermore, 60 international journals in basic or clinical research with IF greater than 6 were selected for the magnitude of contributions of both countries to our scientific Knowledge.

**Results:** In 2010, out of a total of 21 Iranian journals indexed in ISI since 2007, only 12 have a known IF with a mean of 0.39 (range: 0.07 – 0.97), whereas out of 28 Turkish medical journals indexed in ISI, 15 have a known IF (mean: 0.35, range: 0.05 – 0.82). The total number of articles published since 2007 from Iran, total citations and total citations by authors from outside Iran were 2080, 1218, and 463, respectively. The same data related to Turkish journals were 4876, 2036, and 1331, respectively. Indeed, the mean citations per article by foreign authors for Iranian and Turkish researchers were 0.19 and 0.3, respectively. Of the total articles during this period, only seven from Iran and nine from Turkey have been cited at least six times by authors outside the two countries. Iran had 23 and Turkey 37 original publications in highly reputable international journals. Turkey was more represented in basic research and clinical observational studies than Iran.

**Conclusion:** Despite high numbers of published articles, both countries have medical journals with very low comparable citation rates and IF. Only one out of three Turkish articles is cited once by authors outside of Turkey and one of five Iranian articles is cited by authors outside Iran. The few high-cited articles address new therapies and interventional studies or diseases commonly encountered regionally, and are the results of the efforts of a few individuals in highly specialized fields.

Turkish scientists are inclined to publish their scientific works more than Iranians in distinguished international journals. These articles deal more with regional diseases that are not common in Western countries.

Developing countries can only contribute to world science when they focus their efforts on teamwork in order to research ways to solve country-specific diseases and their own health problems.

**Keywords:** assessment, Iran, medical, publications, Turkey

## Introduction

Scientific progress has become an important indicator for the social and economic developments of countries since the beginning of the last century, particularly during the last five decades. Progress in the field of medicine addresses the efforts of medical institutions to participate in the production of science worldwide for maintaining and promoting the population's health.

Extreme changes in the infrastructure of the universities after the

Islamic revolution in Iran with expulsion of some old-system obedient academics initially after the revolution temporarily paralyzed educational and scientific activities at that time. The low number of Iranian physicians that graduated during the previous regime in Iran required employment of many thousands of physicians from eastern Asian countries. The necessity to educate high numbers of practicing indigenous physicians led to an enormous effort to establish new universities, even in smaller cities with various shortcomings and a lack of competent and skilled personnel. Employment of young academics began with an intensive focus to initially educate engineers and physicians urgently required for countrywide development, particularly in western Iran, which had been destroyed by the Saddam-imposed Iran-Iraq war. One and a half decades after the revolution, where the effort in research was disregarded and not con-

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sidered important, a deficit of research emerged and the gap in scientific progress between Iran and its neighboring countries opened the eyes of politicians and found its merit. The governmental organizations responsible for research stimulated the implementation of research centers, rewarded generously and financially the production of scientific papers, and made publication in an ISI indexed journal an indispensable precondition for obtaining any academic qualification. Alongside this new strategy, the number of scientific medical journals during the past ten years has undergone remarkable growth. Many of these medical journals that are published in English have found access into international indexing systems.

This strategy automatically led to the remarkable production of scientific publications during the past ten years. According to various reports, Iran's scientific output increased remarkably,<sup>1-3</sup> and from 2000 to 2008 research has undergone a five-fold increase.<sup>3</sup> Iran is becoming the leader in scientific growth worldwide.<sup>4</sup>

The aim of this study is not only to report on the quantity but also the quality of publications of indexed Iranian journals, to critically evaluate the scientific values of these papers, and to question the necessity of a change in strategy.

The results of this study when compared with data from Turkey, a neighboring Islamic country, should arouse the interest and curiosity of Iranian scientists inside Iran and abroad. This research will allow scientists to openly express their opinions as to how developing countries with limited financial and human resources should adopt optimal strategies in research promotion with the aim to contribute respectably to worldwide scientific knowledge.

## Materials and Methods

The right for publishing a medical journal in Iran is given by the Iranian Ministry of Health, High Education and Hygiene (IMEH).

All approved journals by IMEH listed on the website of [www.magiran.ir](http://www.magiran.ir) were included. Only English journals that fulfilled the qualification criteria to be indexed by ISI and had known impact factors (IF) announced at the beginning of 2010 were included for evaluation. Citation of published articles by authors represents one parameter of the importance for which the level of scientific contribution is measured, therefore we have paid attention to this indicator. However, self- and stimulated citations diminish the importance and validity of this assessment when its part is not considered for evaluation. Therefore, this study has considered the citations of Iranian articles by international authors to be a valuable index. The numbers of all articles published from the beginning of 2007 until October 2010, as well as the number of total citations and citations from authors outside Iran for each journal were calculated. We also selected all articles cited at least six times by authors outside Iran and discussed their content in relation to originality and novelty, as well as their contribution to current knowledge.

With the same methodology, we selected all English journals indexed in ISI from Turkey during the same time period and compared their quality with regard to IF, citations from outside Turkey and highly cited articles.

In addition, for evaluation of the scientific contributions of both countries in international journals, 61 highly reputable journals in basic or clinical research were selected from 311 international medical English journals (see appendix). In 2007, these journals had an IF greater than six and were published internationally from 2007 to October 2010. In these journals, scientific articles from corresponding authors residing in both countries were studied.

## Results

Iran

During the previous two decades, 155 approved journals in the

**Table 1.** List of Iranian journals in ISI indexed system with known impact factor (2007-2010).

Number	Journal name	Total articles	Total citations	Citations by authors from outside Iran	Citations by foreign authors per article	Impact factor
1	Iranian Journal of Allergy, Asthma and Immunology	117	143	51	0.44	0.97
2	Archives of Iranian Medicine	391	410	234	0.60	0.87
3	Hepatitis Monthly	192	140	32	0.17	0.72
4	Daru-Journal of Faculty of Pharmacy	176	138	31	0.18	0.37
5	Iranian Journal of Arthropod-Borne Diseases	62	31	6	0.10	0.35
6	Iranian Journal of Fertility & Sterility	28	17	1	0.04	0.28
7	Iranian Journal of Public Health	349	153	31	0.09	0.24
8	Iranian Journal of Pharmaceutical Research	170	64	38	0.22	0.24
9	International Journal of Fertility & Sterility	93	27	12	0.13	0.22
10	Iranian Journal of Reproductive Medicine	133	29	14	0.11	0.18
11	Iranian Journal of Radiation Research	57	8	7	0.12	0.13
12	Iranian Red Crescent Medical Journal	312	58	6	0.02	0.07
<b>Total</b>		<b>2080</b>	<b>1218</b>	<b>463</b>	<b>Mean=0.19 (range: 0.02-0.6)</b>	<b>Mean=0.39 (range: 0.07-0.97)</b>

**Table 2.** List of highly cited articles from Iranian scientists in Iranian journals ( $\geq 6$  times).

Archives of Iranian Medicine		
1	Mohamadnejad M, et al.	Phase 1 trial of autologous bone marrow mesenchymal stem cell transplantation in patients with decompensated liver cirrhosis. 2007; <b>10</b> : 459 – 466.
2	Mohyeddin-Bonab M, et al.	Autologous in vitro expanded mesenchymal stem cell therapy for human old myocardial infarction. 2007; <b>10</b> : 467 – 473.
3	Balali-Mood M, et al.	Neurotoxic disorders of organophosphorus compounds and their managements. 2008; <b>11</b> : 65 – 89.
4	Mardani M, et al.	Crimean-Congo hemorrhagic fever. 2007; <b>10</b> : 204 – 214.
Iranian Journal of Allergy, Asthma and Immunology		
5	Mirshafiey A, et al.	The role of reactive oxygen species in immunopathogenesis of rheumatoid arthritis. 2008; <b>7</b> : 195 – 202.
6	Hosseini-Farahabadi S, et al.	Association between the polymorphisms of IL-4 gene promoter (-590C > T), IL-13 coding region (R130Q) and IL-16 gene promoter (-295T > C) and allergic asthma. 2007; <b>6</b> : 9 – 14.
Hepatitis Monthly		
7	Alavian SM, et al.	The comparative efficacy and safety of peginterferon alpha-2a vs. 2b for the treatment of chronic HCV infection: a meta-analysis. 2010; <b>10</b> : 121 – 131.

medical field have been established. The majority are published by medical universities ( $n=108$ ), various medical associations in different specialities ( $n=17$ ), research centers ( $n=15$ ) and more recently by unaffiliated individuals ( $n=14$ ). One medical research center publishes two different journals in one field. Three individuals function simultaneously as editors-in-chief of two different journals. Numerous journals are published in the following fields: dentistry (8), psychiatry-related fields (5), cardiology and vascular system (4), oncology (4), nursing and midwifery (4), pharmacy (2) and pharmacology (2), surgical field (3), endocrinology (3), gastroenterology and hepatology (4). No publications exist in internal medicine or gynecology (gynecology is practiced in Iran mostly by female physicians). Over 50 other journals are published but did not achieve the licensing standards.

Among the 155 approved journals, 46 are solely in English, whereas 25 are both in English and Farsi. A total of 21 out of 46 English journals are indexed in 2010 in ISI, while the follow-

ing Iranian journals are indexed in PubMed: Iranian Biomedical Journal, Archives of Iranian Medicine, Iranian Journal of Allergy, Asthma and Immunology, and Iranian Journal of Immunology. A known IF exists for 12 ISI indexed Iranian journals that have been published since 2007 (Table 1). For each journal, the number of published articles during the publication period, total citation, citation by non-Iranian authors, citation per article and IF announced by ISI are presented. Two journals have an IF greater than 0.8: The Iranian Journal of Allergy and Asthma (organ of the Iranian Society of Immunology) and The Journal of the Iranian Academy of Medical Sciences which is also named Archives of Iranian Medicine, a state-owned Medical Association with board members from different Iranian universities and research centers. This journal accepts articles from all medical disciplines.

Another journal has an IF higher than 0.5 due to its high self-citation rate. However, most of the journals have an IF less than 0.3. Two-thirds of the articles published in Iranian journals are cited by

**Table 3.** Contribution of medical science of Iran and Turkey in a number of international journals with high impact factors ( $\geq 6$ ) published 2007-October, 2010.

	Iran	Turkey
Number of original articles in	23	37
Basic research	1	9
Observational clinical study	4	12
Randomized clinical study	5	7
Epidemiology (population-based studies)	6	4
New drug study	1	1
Opinion	4	—
Review articles	1	4
History of medicine	1	—
Case reports	3	21
Images in medicine	8	8
Letters to editors	2	5
Total	59	78
Total citations	292	479
Mean citation per original article (range)	12 (0 – 42)	12 (0 – 62)

**Table 4.** List of Turkish journals in ISI indexed system with known impact factor (2007 – 2010).

Number	Journal name	Total articles	Total citations	Citations by authors from outside Turkey	Citations by foreign authors per article	Impact factor
1	Journal of Sports Science and Medicine	350	360	312	0.89	0.82
2	Diagnostic and Interventional Radiology	207	208	178	0.86	0.77
3	Experimental and Clinical Transplantation	186	127	119	0.63	0.60
4	Turkish Journal of Gastroenterology	154	122	89	0.58	0.48
5	Anadolu Kardiyoloji Dergisi-The Anatolian Journal of Cardiology	718	356	194	0.27	0.38
6	Klinik Psikofarmakoloji Bulteni-Bulletin of Clinical Psychopharmacology	137	31	4	0.03	0.35
7	Turkish Journal of Pediatrics	434	218	168	0.39	0.33
8	Mikrobiyoloji Bulteni	332	141	57	0.17	0.29
9	Turkish Neurosurgery	293	133	95	0.32	0.28
10	Ulusal Travma Ve Acil Cerrahi Dergisi-Turkish Journal of Trauma & Emergency Surgery	347	92	52	0.15	0.27
11	Eklem Hastalıkları Ve Cerrahisi-Joint Diseases and Related Surgery	101	20	6	0.06	0.25
12	Turkish Journal of Medical Sciences	427	82	39	0.09	0.16
13	Turkiye Klinikleri Tıp Bilimleri Dergisi	853	117	16	0.02	0.11
14	Trakya Üniversitesi Tıp Fakültesi Dergisi	218	24	2	0.009	0.08
15	Nobel Medicus	119	5	0	0	0.05
<b>Total</b>		<b>4876</b>	<b>2036</b>	<b>1331</b>	<b>Mean= 0.3 (range=0 – 0.89)</b>	<b>Mean=0.35 (range=0.05 – 0.82)</b>

authors from Iran and one-third by authors outside Iran. One out of five articles is cited only once by non-Iranian authors. Foreign authors have cited 8 out of 2080 Iranian articles at least six times. One review article has been published by a non-Iranian author.

A list of seven selected articles from Iranian authors is given in Table 2 of which four are published in Archives of Iranian Medicine, two in the Iranian Journal of Allergy and Asthma and one in

Hepatitis Monthly. The two highly cited articles address the results of clinical studies on transplantation of mesenchymal cells in patients with advanced liver diseases and myocardial infarction. This field is highly important in clinical medicine and represents a new therapeutic modality for these diseases, therefore it is a subject of debate and not hitherto established in clinical medicine as a successful and effective therapy. The other two articles address

**Table 5.** List of highly cited articles from Turkish scientists in Turkish journals ( $\geq 6$  times).

<b>Diagnostic and Interventional Radiology</b>	
1	Cil B, et al. Peripheral vascular applications of the amplatzer (R) vascular plug. 2008; <b>14</b> : 35 – 39.
2	Yerli H, et al. Evaluation of cerebral glioma grade by using normal side creatine as an internal reference in multi-voxel H-1-MR spectroscopy. 2007; <b>13</b> : 3 – 9.
3	Kamaz M, et al. CT measurement of trunk muscle areas in patients with chronic low back pain. 2007; <b>13</b> : 144 – 148.
4	Yilmaz S, et al. Endovenous laser ablation for saphenous vein insufficiency: Immediate and short-term results of our first 60 procedures. 2007; <b>13</b> : 156 – 163
<b>Anadolu Kardiyoloji Dergisi-The Anatolian Journal of Cardiology</b>	
5	Duygu H, et al. Myocardial bridge: A bridge to atherosclerosis. 2007; <b>7</b> : 12 – 16.
6	Ikizler M, et al. Dietary polyphenol quercetin protects rat hearts during reperfusion: Enhanced antioxidant capacity with chronic treatment. 2007; <b>7</b> : 404 – 410.
<b>Journal of Sports Science and Medicine</b>	
7	Karlı U, et al. Influence of Ramadan fasting on anaerobic performance and recovery following short time high intensity exercise. 2007; <b>6</b> : 490 – 497.
<b>Turkish Journal of Medical Sciences</b>	
8	Kerem M, et al. Effects of acute fenthion toxicity on liver and kidney function and histology in rats. 2007; <b>37</b> : 281 – 288.
<b>Turkish Journal of Pediatrics</b>	
9	Kocabas E, et al. Role of procalcitonin, C-reactive protein, interleukin-6, interleukin-8 and tumor-necrosis factor-alpha in the diagnosis of neonatal sepsis. 2007; <b>49</b> : 7 – 20.

**Table 6.** Comparison of contributions to medical sciences in ISI indexed journals of both countries (2007 – 2010).

Country	No. of indexed journals in ISI with impact factor	Total articles	Total citations	Citations by foreign authors per article (mean)	Impact factor (mean)	No. of articles cited $\geq 6$
Turkey	15	4876	2036	0.3	0.35	25*
Iran	12	2080	1218	0.19	0.39	8*

\*=Only 9 of 25 articles in Turkish and 7 of 8 articles in Iranian journals were from domestic authors.

the epidemiology of two uncommon diseases that have occurred in Iran; one disorder is caused by chemical bombs applied by the Saddam regime against the Kurds in the Iran-Iraq war and its therapy, while the other addresses the epidemiology of Crimean-Congo hemorrhagic fever which occurred in one area of Iran during a short time period. A review article addresses an update of the epidemiology and therapy of hepatocellular carcinoma and was written by a non-Iranian author. Review articles have been frequently cited when written by competent personalities. The last two highly cited articles consist of a review article on the relevance of reactive oxygen in the immunopathogenesis of rheumatoid arthritis and of the polymorphisms of genes in allergic asthma. The discoveries of new drugs in Iran for AIDS therapy, diabetic food ulcer or gastric cancer did not generate interest by non-Iranian authors.

Over three years, Iran has published 25 original articles in international medical journals with high IF, of which eight were epidemiologic studies related to common diseases (diabetes and metabolic syndrome, squamous cell cancer of the esophagus, and stroke) from the Nutrition Research Center and Department of Endocrine and Metabolic Research Center at Isfahan University, the Digestive Disease Research Center at Tehran University and other centers. Five studies were related to randomized clinical trials and four to observational clinical reports. Four articles represent opinions stated by different scientists. Only one belongs to basic experimental research and three articles relate to different items (one, a non-randomized new therapeutic study; one, a medical historical report; and one, a review article). Details of all original articles and all non-original publications from Iran and Turkey are given in Table 3.

#### Turkey

Of 28 Turkish journals that have been indexed in ISI, the IF of 15 journals published since 2007 are known. Seven of these are indexed in PubMed. A listing of these journals is found in Table 4. All journals listed had an IF of  $<1$ , however, four had an IF of around 0.5 or higher. The majority of Turkish journals have an IF around 0.3. The self-citation rate among Turkish authors is less than Iranian authors.

During the publication period, 25 articles in Turkish journals have been cited at least six times or more in the following journals: Journal of Sport Science and Medicine (10), Diagnostic and Interventional Radiology (5), Anatolian Journal of Cardiology (4), Experimental and Clinical Transplantation (3), and the remaining three articles have been published in two other journals. Many articles from authors outside of Turkey are published in the Journal of Sport Science and Medicine as well as Experimental and Clinical Transplantation. Sixteen out of 25 highly cited Turkish articles are only derived from authors outside of Turkey, mostly from the USA and Germany. The list of nine highly cited articles from Turkish authors is given in Table 5. Of these articles, two address interventional therapeutic studies with follow ups of patients in cardiology (occlusion of anastomosis) and angiology (endovenous laser abla-

tion); two are in the field of diagnostics (grading of brain tumors, procalcitonin and other serum markers in children with sepsis); one observational clinical study; two observational studies with interesting clinical findings (Ramadan and sports performance, and muscle mass in patients with low back pain); and two are in basic and experimental research.

A comparison of the summary of scientific contributions of Turkey and Iran is illustrated in Table 6. Although the numbers of articles published in Turkish journals is higher than Iranian journals, no remarkable difference can be observed in the scientific achievements of both countries with regards to their IF in ISI indexed journals and the numbers of highly cited articles. Many highly cited articles in Turkish journals come from authors outside Turkey.

Turkey has 37 original articles in international medical journals whereas Iran has only 25 articles (Table 3). The original articles from Turkey consist of observational clinical studies as well as basic research. The citation rate per article is the same for both countries. Randomized clinical trials or observational studies are cited more than articles published in basic research. The mean citation for basic research articles is seven for Turkey and nine for Iran.

Good observational clinical reports comprise 12 out of 37 articles, of which some have hundreds of patients in long-term follow ups of up to 19 years. The results from basic or experimental animal studies are seen in nine articles, seven are the results of randomized clinical trials, four are population study results, four are review articles and one pertains to a new non-controlled therapeutic study. The clinical publications focused on common diseases in Turkey such as Behcet disease (two articles), BCG vaccine for tuberculosis prevention, Parkinson disease, Mediterranean fever, the natural course of 847 newborns, irritable bowel syndrome after trichinellosis, rotavirus infection in 411 children with gastroenteritis, myoclonic seizures in 48 patients with juvenile epilepsy over 19 years of age, and surgical complications of 101 liver donors.

## Discussion

Medical journals published in English, as shown in this article, have a very low citation rate and are not considered or cited by the international medical audience. The assumption is that Iranian papers will be generally disregarded from international consideration due to unscientific reasons cannot be accepted as valid, as some papers from Iranian journals had high citation rates and could have been published in international journals with high IF. The contents of these highly cited papers deal with new knowledge about diseases not commonly encountered in developed countries or they present results of new therapeutic methods, where either no or limited experiences exist in other countries. The review articles also give updated, good information about common diseases.

Therefore, Iranian English journals are respectably high in num-

ber and represent a general collection of publications with scientific irrelevance or non-citable value due to a lack of novelty and innovation. They contain articles with knowledge previously published in developed countries or have inadequate methodology unacceptable for international scientists. As the publishers of the majority of journals are universities or research centers, the results of their own works are self-published, which are not probably acceptable for publication in international journals and most likely not subject to review by independent scientists.

The number of Turkish journals indexed in ISI is higher and their self-citation rate is lower than those in Iranian journals, but their IF does not differ.

One characteristic pattern of journals from both countries is the inhomogeneous nature of journals with different IF; certain fields are strong in one country but weak in another (research in allergy and immunology in Iran and sport science in Turkey). This indicates that research institutions are quite young and not established in all research fields in both countries. The intensity and high quality of research is limited to a few fields and dependent upon the efforts of a very few engaged personalities working in these countries.

We did not study the magnitude and variation of IF in other countries in Asia, Africa, or Latin America, but we suggest that journals in all developing countries, as with Iran and Turkey, have generally low IF.

A low IF of medical journals from both countries is the reason why authors in Turkey and Iran did not publish their important results, even on common diseases encountered in this geographic area in their domestic English medical journals, but rather preferred to publish their important results in international journals of high reputation. Turkish scientists are more active in basic as well as clinical research, and publish very good observational clinical studies with high numbers of patients and long-term follow up when compared with Iranian scientists. This capability results from the different structure of universities with fulltime work of department heads of many universities in Turkey, which differs from part time work of Iranian university scientists.

Is a low IF due to the general course and natural history of any newly published medical journal? This can be a probable cause for the low citation rate; however, some journals during the same publication period have higher IF than others, which shows that the content, but not the length of publication plays an important role.

In developed countries, some renown universities were established decades and even centuries ago. Their important research centers and scientific institutions do not publish their works, but rather send them to journals published by scientifically strong associations.

Journals with high quality articles and high citation rates are usually published in countries where research tradition exists over many decades and centuries. They have the best educated scientists in innumerable institutions led by distinguished researchers who persistently focus on special fields of research and are in continual and constant communication with their counterparts in other countries.

Countries lacking in scientific tradition and the necessary scientific background in combination with an inadequate infrastructure and low financial budget for research do not have adequate numbers of qualified, full time scientists educated in world renown scientific centers and lack open, free, and non-restricted communication, therefore they remain at the bottom with regards to scientific

reputation. Because of these insufficient possibilities and shortcomings, they are not able to contribute to contemporary scientific knowledge and are unable to compete with developed countries to produce publishable high quality research in highly reputable journals of western countries.

An additional consideration for the low quality of scientific publications from both countries is the obligatory requirement implemented by university authorities for candidates who wish to obtain the title of associate professorship. In both countries, candidates are obliged to publish at least two to five articles in an indexed English journal without consideration for the novelty and originality of their publications. In developed countries, the number of publications is not the requirement, but rather the quality and originality confirmed by competent researchers are indicators for promotion.

Which policy has to be implemented by responsible authorities of developing countries in health research with limited human and financial resources?

As long as the scientific infrastructure in developing countries is not available and scientific budget is scarce, developing countries should maximize their efforts to focus and restrict their attention to special fields of research limited to solving urgent problems in their societies. The research should be country and society-specific oriented. The high citation rate of this type of publication in domestic or international journals as shown in this article provides evidence for employing this strategy.

The distribution of a limited scientific budget (0.6–0.8% of GDP in Iran versus >2% in developed countries) must be performed by an independent committee led by highly qualified scientists, not by state-owned institutions influenced by temporarily elected politicians.

Basic research, not patient-oriented, can be efficacious for the development of new diagnostic methods, in addition to new drugs or medical devices that affect prevention or disease courses and their partial or complete healing. However, they usually devour enormous financial resources and rarely produce results translatable to practice.

During the past decade, the budget for basic research was diverted in rich countries to translational science, which has required close cooperation of a team of multidisciplinary scientists from disparate basic and practical fields.<sup>5</sup> When strong groups in basic research exist they have to focus on mandatory cooperation with clinicians in developing countries. Clinical-based research must be focused on the diseases which are common and of great concern for the society.

The morbidity and mortality rate in different geographic areas of a country can be an important field of research for determining risk factors and their prevention. Epidemiological studies such as cohort studies in limited areas that are well-designed, with long-term planning, and careful follow ups provide new knowledge, which can contribute to science. Teamwork and patience are necessary to obtain results after a lengthy period of time. Are we able to constitute a corresponding infrastructure for such studies?

Randomized controlled clinical trials can be best performed in developing countries when the cost of needed agents and instruments are adequate.

Prevention of cardiovascular diseases, obesity and its associated diseases, high traffic accidents in Iran, asthma among the urban poor who have emigrated from rural areas during the last three decades, and exposure to air pollution due to the increase in traffic

are important research fields.

Is the prevalence of diseases different in relation to different exposures to air pollution and when gas instead of oil becomes the main fuel for all vehicles? Opium addiction, the high incidence of gastric and esophageal cancer in some areas of Iran, high hepatitis B infection rate and their prevention by interventional studies are tremendous challenges for the population's health.

By having adequate data collection and patient specimens (tissue, blood or serum samples, optimal bio-banking), scientists in Iran can be certain of better cooperation and partnership with cancer research centers in developed countries which need materials for performing such cost-intensive research, similar to the cooperation between eastern Asian countries and the U.S.A.<sup>6,7</sup>

Scarce budgets and resources for research should be granted to all who are qualified to conduct solid research with the aim of solving local health problems. This can only be possible when the eyes of academics turn to teamwork and eliminate single individual activity. Neither a single scientist nor single research center can produce high quality research without the contributions of other research centers.

Scientists in developing countries are best advised to avoid conducting studies already completed in western countries with the aim to confirm or to refute the results. The majority of such studies have a weak methodology and small sample size; we encounter this category of research often in Iranian journals. Researchers should conduct a limited number of well-designed clinical intervention studies, elucidating the changes in disease prevalence. This is a large challenge for Iranian researchers, but worthwhile for the production of new knowledge contributing to the world of science. There are numerous English journals in Iran, often many published in the same field with low citation; these should be dissolved or combined in order to constitute a few English journals that publish papers connected to the health problems of developing countries.

Not all academicians employed in university settings are prepared initially for research. Academicians should not be forced to publish solely for the promotion of a paper in English. When they are qualified and interested in teaching with a high clinical competence, they can continue teaching university academics. This strategy reduces the number of journals with worthless publications inaugurated by universities whose aim is promotion of their academic personnel. The obligation to publish scientific papers can produce increased plagiarism and fabrication in medical journals.

In the long run, journals published from individual personalities and individual research centers have no future. They should be dissolved in favour of journals published by special medical associations, which could be rather attractive to specialists in one particular medical field, enabling cooperation.

A look at the development of science during the previous centuries in traditional scientific-oriented European countries such as England and Germany has shown sustainable and continual growth in science, and slow increase in scientific journals by mutual efforts of many scientists working together in communication and cooperation. Respectable achievement in science can only be sustainably produced when scientific innovation is the aim and goal of our action and not high IF artificially produced by self- and stimulated citations. Neither the high number of scientific journals nor the number of scientific papers indexed internationally, as have been shown in the two developing countries of Turkey and Iran, are expressions of scientific accomplishment and performance.

China, as a developing country with enormous human potential has produced thousands of journals in the last 30 years in science. The responsible governmental body has now verified that a huge gap exists between quality and quantity of medical journals that were read by no one and riddled with plagiarism. China intends to terminate the weak journals and focus on publication of a few high quality journals.<sup>8</sup>

The effort of establishing the abovementioned strategy can free limited human and financial resources for production of high quality research as valuable contributions of developing countries to world science and for helping to improve and maintain the population's health.

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## Appendix

The names of highly reputable journals in basic or clinical research evaluated for this study:

Journal Name
New England Journal of Science
Annual Review of Immunology
Nature
Cell
Lancet
Annual Review of Biochemistry
Science
Journal of the American Medical Association
Annual Review of Pharmacology
Endocrine Reviews
Lancet Neurology
Journal of Clinical Oncology
Pharmacological Reviews
Lancet Infectious Diseases
Journal of Clinical Investigation
Circulation
Lancet Oncology
British Medical Journal
Gastroenterology
Psychological Bulletin
Annual Review of Microbiology
Microbiology and Molecular Biology Reviews
Journal of the American College of Cardiology
American Journal of Psychiatry
American Journal of Human Genetics
Current Opinion in Immunology
Hepatology
Blood
Annual Review of Medicine
Archives of Internal Medicine

Journal Name
European Heart Journal
Journal of Cell Biology
Brain
Gut
Annals of Neurology
Journal of Allergy and Clinical Immunology
Psychological Review
Diabetes
Leukemia
Neurology
Annals of the Rheumatic Diseases
Annual Review of Public Health
Annals of Surgery
Journal of Hepatology
Stem Cells
Cancer Research
Canadian Medical Association Journal
Arteriosclerosis, Thrombosis, and Vascular Biology
Stroke
Clinical Pharmacology and Therapeutics
Clinical Cancer Research
Diabetes Care
Drug Discovery Today
Hypertension
American Journal of Transplantation
Critical Care Medicine
American Journal of Gastroenterology
Journal of Infectious Diseases
Cardiovascular Research
Journal of Immunology