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Scientific Research and Scientific Performance Evaluation

Bilimsel Araştırma ve Bilimsel Performans Ölçümü

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Summary

Scientometric indices to evaluate scientists, scientific publications, journals and institutions (citations and H-index) were reviewed and a survey of Turkey according to those metrics is provided. Unfortunately we have reached a conclusion that our scientific research should have more efforts to approach to the level of the general scientific world. (Turkish Journal of Neurology 2014; 20:32-5)

Key Words: Scientific criteria, H-index, impact factor

Özet

Bilim adamları ve bunların yayın ve atıfları, bilim dergileri ve bilim kurumları için geliştirilmiş "scientometric" ölçütler (atıflar ve H-endeks) gözden geçirilmiş ve bu duruma ait değerler Türkiye'dekilerle karşılaştırılmıştır. Ülkemizin bilimsel değerler açısından çok daha uzun bir yol kat etmesi gerektiği sonucuna varılmıştır. (Türk Nöroloji Dergisi 2014; 20:32-5)

Anahtar Kelimeler: Bilim ölçütü, H-endeksi, etki faktörü

Introduction

The curiosity pushed human beings to ask questions and seek answers since the early ages. This motivation marks the birth of science.

Scientific information began to be published in the scientific journals controlled by scholars at the end of 19th and 20th Centuries. Being neutral at the moment of its creation, scientific knowledge becomes beneficial to the society once it is converted into innovations. Harmful policies, on the other hand, also allow this knowledge to do harm in the society as well (1,2). Here we discuss the producers of scientific knowledge and the quantifiable metrics of this knowledge.

It should first be discussed what sort of qualities must a scientist possess

1. Curiosity and a desire to reach the truth should come before everything else
2. Such individuals must have an inquisitive and critical way of thinking.
3. An intuition about truth and perceptiveness must be present.
4. There must be willingness to pursue a scientific question to its end. In other words, discipline and perseverance are essential.
5. They should be truthful to themselves and to others.
6. They should have an outstanding sense of responsibility. This includes responsibility about the study undertaken as well as a societal responsibility (7).

Ultimately, we can say that science is an arduous profession that requires talent, motivation and enthusiasm in addition to being a career option (6).

The biggest joys that it can give to a human being is only the promise of truthful knowledge and therefore making a contribution to the collective mind. Science has no room for prospects of money, prestige and fame.

I would like to give an historical example on the scientific motivation. Lavoisier is a milestone in chemistry. He was unfairly prosecuted and sentenced to death by guillotine during the 1789 French bourgeoisie revolution. Helplessly coming to terms with his fate, Lavoisier tells a close friend how he wonders how much

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he will remain alive after he is decapitated. He tells his friend that he will blink twice after he is decapitated and instructs him to pay attention to his eyes. According to his friends he did blink after his death. The rumors on the incident are of course in abundance. The important point here is that a scientist takes the desire for knowledge to grave, even knowing that the knowledge will never be available to him. The fact that humanity will learn about the truth is what matters.

When discussing the properties of the scientist and science, we should start by discussing scientific journals which is the medium of knowledge.

We can categorize the publications (printed or electronic) in which the scientific performance is presented into 4 different categories (1,3):

1st Group: The journals with substantially wide range of scientific audience and high impact factors. These journals reject 85%-90% of the articles that were sent to them. New England Journal of Medicine, Lancet and Science can be considered as some of such journals.

2nd Group: Journals that focus on specialized areas and subjects. Their rejection rates change between 60-80%. Journals such as Brain, Blood, Circulation and Human Genetics can be considered in this group.

3rd Group: Educational journals, publications of various organizations or journals with very narrow subjects are in this group. They reject 50%-70% of the submissions. Journals such as Multiple Sclerosis or Sleep can be considered in this group.

4th Group: The journals that publish for fees. They have very low rejection rates but ethical violations are not uncommon in this group.

The primary determinant of this classification is a concept called the impact factor. Impact factor can be considered as an indicator of how valuable a publication is. Impact factor of a journal changes every year. It is first proposed by Garfield in 1976 to measure the importance of a publication (8-10). Let us say that we are measuring the impact factor of a publication in 2013. We will need two pieces of information: First, the number of citations that the journal received for that year (2013) and secondly the number of articles published in that journal in the past two years (2011, 2012).

The impact factor is calculated by dividing the citation count by the number of articles published in the past two years. Most established journals release their impact factor for the past 1 year and 5 years in all of their volumes.

There is also another scientific metric called the immediate factor. This factor is calculated by dividing the number of citations in the previous year by the number of articles published that year. This provides a quality index regarding the recent efficiency of the scientific activity. The index is higher when the information is consumed more rapidly. Medical journals, for example, have higher indices, as well as journals that publish 12 times a year as opposed to twice or 4 times (3,9).

There have also been metrics developed to measure the scientific performance of individuals. It should be noted that there is still no method for telling the value of a new finding and how much influence it will make ahead of time. The usefulness of all of the metrics shown here are open for debate. Until better ones are devised, however, we will use the existing ones.

Number of publications is the most straightforward performance metric. One important point is that the number itself is not a definitive proof of scientific proficiency. This also applies to scientific institutions. Sometimes the pressure to publish can cause a higher rate of ethical violations. We see instances of this commonly in doctorate studies. Albert Einstein can be an example here. According to a physician colleague, Einstein published only 27 articles throughout his lifetime and four of these papers shook the world. In short, quality should be prioritized over quantity.

Citation count is one of the most common metric for scientific performance. It describes the times where your publication is used in another publications as a reference. The citation count also changes by the discipline. In biological sciences, for example, citation counts are higher than that of social sciences.

In medical sciences, we also observe a variation in citation counts according to branches. Oncology, immunology and genetics studies have higher citation counts. In the limited and specialized topics such as degeneration and certain local diseases, citation counts are much smaller.

Citations of individuals are monitored by the periodicals called Science Citation Index (SCI). The most famous one among them, International Scientific Index (ISI) by Thompson Scientific, was actually founded by Garfield in 1960. International Scientific Index is the most comprehensive and retrospectively complete one among SCI citation database. Its records start from 1900 and include more than 150 scientific disciplines. It includes about 6000 journals. After 1994, there have been two additional resources for citation databases. These are SCOPUS and Google-Scholar.

H-index: This index is a relatively new way formula used for evaluation. First proposed by a physicist named Hirsch in 2005, H-index of a scientist is computed using citation and publication counts. The publications are ordered from the most cited to least cited and are placed on the vertical axis of a right angle. Publication count is placed on the horizontal axis and a curve is drawn between the corresponding points between the two axes. H-index is the projection of the intersection point of this curve and the angle's bisector on the horizontal and vertical axes (Figure 1) (3,11).

H-index has recently become common. Even though it has some down sides like the other metrics, it is currently the most commonly accepted one. There are also other, more novel metrics. They will not be discussed here.

Publication-time relationship: The citation rate of a publication changes over time. At the beginning, an increase can be seen after the first 2-3 years. A publication receives fewer citations as it gets older. This is called obsolescence or publication aging. Half-life or aging terms are used to indicate this process (3,5,7,12). I would like to give an example to this using our own publications. Figure 2 shows a typical example of aging. The publication was made in 1976. After receiving a lot of citations, we see that the rate starts to decline and the publication's content was made obsolete by new methods and information. For example, the citation rate declined after 1990. So the half-life of the publication is 14 years. This duration is typically around 10 years. On the other hand, some articles can keep receiving citations for longer durations. They often contain knowledge that became textbook material. For example, this article was published in 1976 and kept receiving citations until the year 2013 by varying amounts throughout the years (Figure 3). This indicates scientific knowledge that is still relevant 37 years after its publication.

Sometimes a publication can be evaluated within a very small time. A relatively new article compared to the previous ones has been shown here (Figure 4). The citation count increases between the years 2003 to 2013. From this, we can infer that the half-life of the article will be very long.

A peculiar time-citation relationship that has not been focused on in the scientometric literature has been shown (Figure 5). The study was done in 1975 and did not receive a lot of attention in its first years. The citation rate between the years 1980-2006 was extremely limited. After the year 2006, however, the citation rate shows an unexpected spike. This pattern can be explained like this:

a) The subject matter of the article probably gained more importance after 2006

b) The study was overlooked in its first years

Based on this, I would like to express that young researchers should not be discouraged with the quiet reception to their studies. The value of a study can increase in time, even after years.

Even I could not find any information predicting the duration in which an article may continue to receive citations, we can say that this duration can be up to 40-45 years.

Turkey's Status In Terms of Performance Relationships

The first publication with Turkish origin in SCI dates back to 1922. There had been 37 publications between the years 1922 and 1972 (3,10). In the 33-year duration between 1972 and 2004, we see an increased publication rate. During this time, there had been 89011 publications (ranging from medicine to social sciences) (Figure 6). At the same time, this number represents 4/10,000 of the global publications. The studies were published in 5033 different journals. The increase in the publication rate is correlated with the activity of the program that provides funding and academic support to Turkish scientific research. The support from the universities, TUBITAK and TUBA should also be added to this list. The requirement for international publications in the academic system also contributed to this rate (5,13).

An interesting point is that 3/4 of Turkey-originated papers indexed by SCI were published in Turkish journals. Even though these journals were indexed by SCI, their impact factors are very low.

Now let us look at the citations from Turkey. Sadly, 40% of the Turkey-originated papers published in journals indexed by SCI did

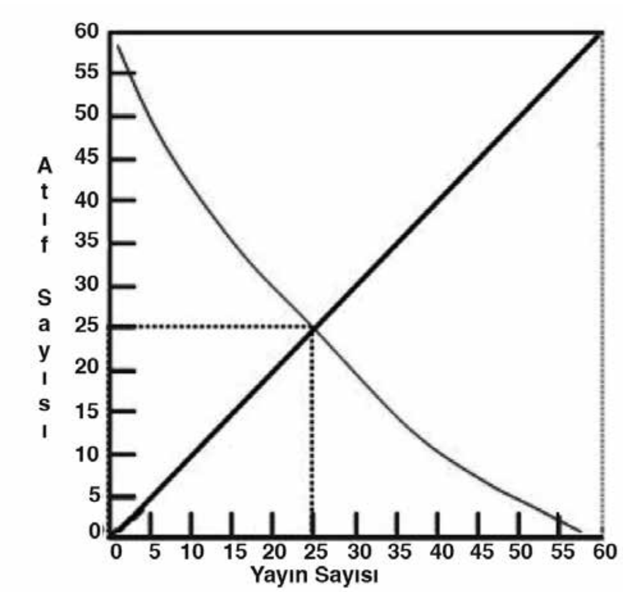

Figure 1. Computation of H-index (U Al. 2008)

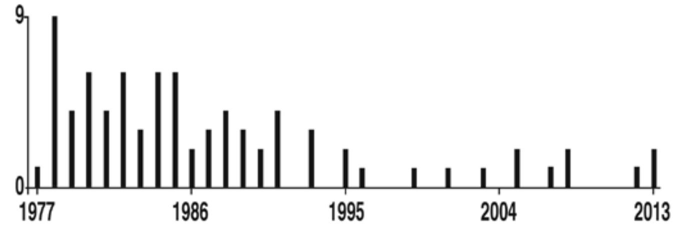

Figure 2. Studies on the human evoked electrospinogram. C Ertekin. Acta Neurologica Scandinavica 1976

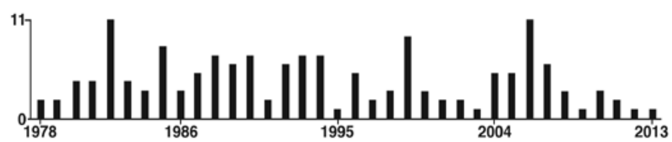

Figure 3. Bulbocavernosus reflex in normal men and in patients with neurogenic bladder and/or impotence. C Ertekin and F Reel. J Neurological sciences 1976

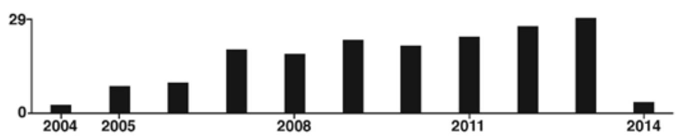

Figure 4. Neurophysiology of swallowing. C Ertekin, İ Aydoğdu. Clinical neurophysiology 2003.

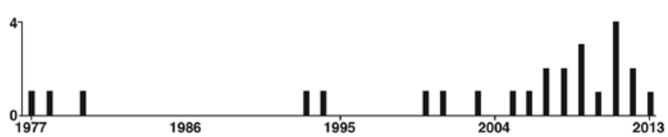

Figure 5. Ertekin et al.:Conduction velocity along human nociceptive reflex afferent nerve fibres. J Neurol Neurosug Psychiat 1975

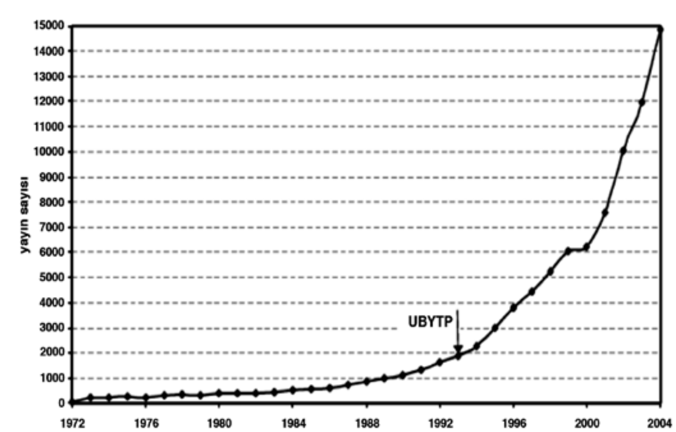

Figure 6. Turkey-originated publications in SCI between the years 1974-2004 (Taken from U Al. 2008)

not receive a single citation. According to another study, 48% of the articles in the medical sciences did not receive any citation (5,13,14).

The articles with a single citation constitute 25% of the total number.

As it can be seen from Figure 6, the mean citation count fluctuated between the years 1970 and 1990 and it got into a decreasing trend after 1993. The mean citation count changes from 9 to 10. Some studies receive citations even 20 years after their publication. The studies made by Turkish researchers often do not receive citations immediately after their publication.

The percentages of the citations to Turkey-originated papers in SCI are also given. As it is seen on the table, the percentage of publications that receive no citations is 35. According to another publication, this number is 40%. The percentage of publications that received 1 to 5 citations is 41.3%. The sum of these two groups is 80% (3,14).

The publications that received 15 or more citations constitute only 5.8% of the total number. This number can seem small but it is a sign showing that important studies are made in Turkey, even in small numbers (3).

We can presume that publications with high citation numbers make important contributions to science. These publications are important in improving the reputation of a country in the scientific community. Nineteen percent of the Turkish publications with high citation numbers received 68 or more citations. There are 287 of such publications.

Looking at the distribution of these 287 publications across disciplines, we see that 92 of them come from medicine. This is followed by physics, chemistry, genetics and other sciences. We can say that neurology and the study of brain is at the second place in terms of impact factor. In terms of the scientific disciplines, the most commonly cited ones are molecular biology and genetics, followed by immunology. Neurology and neuroscience are at the third place. This situation is an evidence for the substantial potential for the original studies made by us neurologist on brain, spine and nerves to receive high number of citations. Neurology and neuroscience seem to be fruitful areas and research endeavors on these areas should be supported.

In summary, the citation count per study in Turkey is far below the global average.

1. Turkey ranks 14^{th}-42^{nd} globally for publication count in different scientific disciplines (mean: 26^{th} place).

2. Turkey's ranking for citation count per publication is between 27^{th} and 104^{th}. That means the contribution to the scientific literature, despite the high volume of publications, is very low (mean: 30^{th} place).

3. The biggest contribution to medicine is made in the field of clinical medicine. These, however, constitute only 1.4% of all publications. Turkey placed 16^{th} in publication count but it placed 102^{nd} for citation count.

I would like to make one more point in addition to these facts. This study also found that the publications made in Middle Eastern countries like Egypt, Iran, Iraq, Jordan, Saudi Arabia, Syria and Turkey in the field of physics in 1990-1994 constitute only 1% of the global physics literature (15). We call these Middle Eastern countries "Developing countries". The possible causes for the scientific retardation are listed one by one (Table 1).

Turkey is an economically and socially underdeveloped country. Now this picture also includes political-administrative and judicial setbacks. This, however, does not predicate the notion that "Science does not take priority". This notion is not fruitful in the long term. It goes without saying that scientific thinking and critical reasoning are the best antidotes for the regression that has recently plagued the collective consciousness of the nation.

Table 1. The causes of scientific underdevelopment in developing counrtries
The lack of a scientific tradition.
Dogmatic way of thinking instead of rational/critical thinking.
Developed countries are reluctant to share their advancements.
The lack of scientific and cultural planning and infrastructure to fully utilize qualified personnel.
The disconnect between scientific institutions and society. Basic scientific knowledge that is easily applicable to daily life is hindered by dogmatism and religious ways of thinking.
Cultures of coups and societal discontent fail to raise second or third generations of scientists.

My last remarks for the young scientists:

1. Do not do science for the prospect of advancing in your academic career
2. Use science only to satisfy your curiosity and the need to achieve knowledge
3. Make your scientific endeavor a life-long affair
4. Do not waste the reputation you made with science for prestige, money, fame and social capital.
5. Be patient and determined in your scientific career.

There is no monetary substitute for the satisfaction, pride and honor that can replace your contribution to the universal body of scientific knowledge will provide.

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