

# Webometrics-based Analysis and Ranking of Iranian Hospital Websites

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## Abstract

**Background and Objectives:** Active presence of hospitals on the Internet is becoming a hallmark of hospitals' commitment to quality healthcare services delivery. For insightful planning towards a strong Internet-based information delivery and communication, there is a need for continuous monitoring of hospital website's status. Built on this need, this paper provides, for the first time, a ranking of a large number of Iranian hospital websites based on standard webometric methods.

**Methods:** The study targeted ranking of all hospitals affiliated with the Iranian Ministry of Health and Medical Education. Name and URLs of the hospitals were obtained from the official website of the Ministry and then updated using web search, when needed. Hospital websites with un-standard URLs and extremely limited content were excluded from the study, and the remaining websites were analyzed and ranked according to webometric measures.

**Findings:** A ranking list of 93 hospitals was obtained. The three top-rank websites belong to the hospitals affiliated with Tehran University of Medical Sciences followed by websites of hospitals of Beheshti and Shiraz universities of medical sciences. The top 20 websites belong to hospitals affiliated with only seven medical universities among 17 surveyed. The size, visibility, and richness of hospital websites showed significant intercorrelations ( $P < 0.001$ ). In addition, regression analysis identified significant linear relationship between hospital websites' visibility and size ( $\beta = 0.6$ ,  $P < 0.001$ ). On the other extreme, websites of most hospitals affiliated with Babol, Ahwaz, and Hamedan, and Birjand universities of medical sciences constitute the lowest 10 rank group. While these low rank hospital websites slightly differ in size, they share an identical rank (the lowest among all) in terms of visibility and richness.

**Conclusions:** This obtained ranking list of the hospitals can help hospital administrators to evaluate the strength of their on-line presence and plan to improve their status on the web. The fact that the top 20 and the lowest 10 rank hospital websites cluster into a few medical universities highlights the importance of support from holding universities for strong presence of their affiliated hospitals on the web. In addition, identification of significant positive relationship between size and visibility of hospital websites encourages hospital administrators to synergistically improve their webometric rank by increasing the size of their websites.

**Keywords:** Webometrics, Hospital, Web, Website, Information and Communication Technology, Internet, Ranking

## Background and Objectives

Decades after emergence of the Internet, this phenomenon now affects virtually all aspects of human activities, and contributes to different areas of social and personal life. Many challenging aspects of the emerging technologies are not revealed but several years after their first appearance. The Internet is not an exception to the rule; the information technology professionals have been trying for years to identify and resolved inadequacies and insufficiencies of this technology.

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One of the most instrumental ways for improving the Internet services is enabling qualitative and quantitative analysis of the web by means of webometrics. Webometrics accounts for link analysis, web citation analysis, evaluation of the search engines, and in general, descriptive study of the web. Webometrics is defined as "the study of the quantitative aspects of the construction and use of information resources, structures and technologies on the web by applying bibliometric and infometric approaches" [1-4]. This definition covers the qualitative, quantitative, content-related, structural, and applicable aspects of the web, and helps incorporation of the "webometrics" as a technical word in the terminology of bibliometrics and informatics.

The research in webometrics falls into four major topics: 1) Content analysis of web pages, 2) Structural analysis of web links, 3) Analysis of web applications (including analysis of the report files and the user exploratory behavior), and 4) Analysis of web technologies (including analysis of the performance of search engines) [2]. One of the main research areas in webometrics is recognized to be the identification of common aspects between the citations and web links [2].

In the era of information and communication technology, the on-line face of an organization can be easily taken as reflecting the quality of services delivery by the organization, of-line. In particular, in the healthcare domain, active presence on the Internet is increasingly becoming a health organizations' commitment to provision and delivery of quality healthcare services. To keep with this situation, health organizations need to develop informative and rich-content websites, continuously monitor their their websites' performance and keep them update with the fast changing nature of the technology.

As a contribution to addressing this need, this study was designed to provide a ranking of a large number of Iranian hospitals.

### Literature review of the webometrics

In recent decades, several webometric studies have been conducted in different countries. Most early studies were focused on evaluating the number of web links [1]. Webometrics was born in 1997 with indices similar to bibliometrics [1]. In the following years, most studies focused on using the hyperlinks to produce impact indices as in analogy between the web links and the citations [2, 3]. The studies in the mentioned areas led to the following findings:

- 1) The number of links of academic websites is related to universities' research performance [4];
- 2) For further performance, the universities should publish more online documents [4,5];
- 3) The hyperlinks are not reliable indices for evaluating the journals' impact factors [3,6];
- 4) There exist several creative methods for representing the websites based on their links or communications [7,8];
- 5) The alternative links are necessary to be evaluated [9-11].

In 2004, Qiu *et al.* [12] ranked the websites of Chinese universities based on web impact factors. Later, Aguillo *et al.* (2006) presented an appropriate measure for ranking the world universities [13]. Stuart *et al.* (2007) [14] analyzed the correlation between the websites of the European universities, and concluded that the cooperation of the universities with commer-

cial firms yields important implications for national economy. Kausha and Thelwall (2008) [15] studied the relationship between the webometrics and different scientific policies, and developed a conceptual framework for webometric evaluation of personal fields. Their findings recommended the use of webometrics for supervising new fields, in particular the strategic ones.

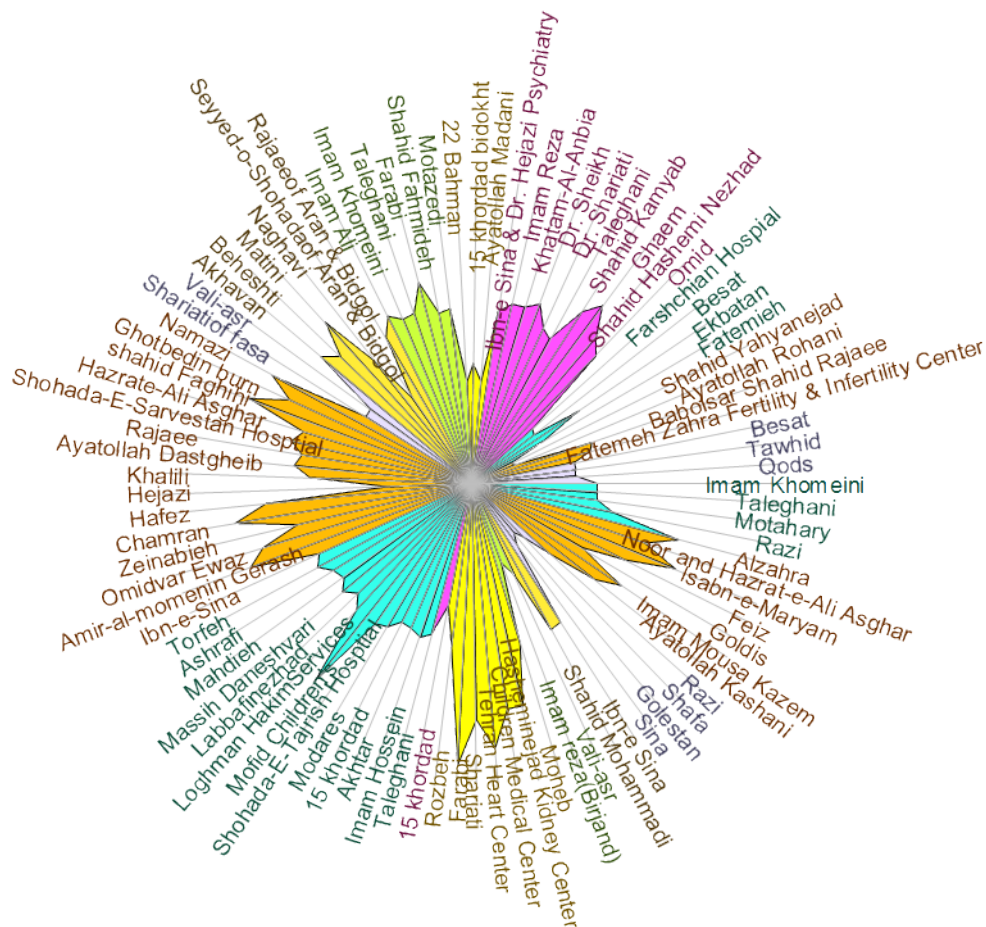
In 2010, Spain Cybermetrics [16], a website dedicated to webometric analyses, released a ranking list of the world hospital websites. While the website of New York University Langone Medical Centre gained the first rank in the globe, the Tzu Chi Hospital's website received the first rank in Asia. In this ranking effort, 46 Iranian hospital website were taken into account among which, hospital websites of Tabriz University of Medical Sciences (rank 13), Hamedian University of Medical Sciences (rank 42) and Gilan University of Medical Sciences (rank 60) were among the top 100 Asian hospital websites. No Iranian independent hospital was included in the top 100 Asian websites.

### Background of webometrics in Iran

Parallel to the line of world-wide research, several webometric studies have been conducted in Iran. For instance, in 2011, Noruzi investigated the web presence and impact factor of the national main code domain and the academic subsidiary domains in the Middle Eastern countries [17]. The author concluded that the website-specific characteristics can influence its impact factor. It was also revealed that the websites in the Middle Eastern countries had not sufficiently drawn the attention of the World Wide Web users due to language reasons. Moreover, the results of this study surfaced the peninsula-like structure of the websites of the Middle Eastern countries; these websites were nationally well connected but they were not sufficiently connected to the international websites.

In 2008, Shekofteh *et al.* ranked websites of Iranian universities of medical sciences using the impact factor method [18]. Further, the websites of Iranian pharmaceutical schools were ranked by Aminpour *et al.* (2009) [19]. In 2011, Fakhree and Jouyban [20] conducted a comparative webometric study of the Iranian medical and pharmaceutical schools. The results indicated that websites of medical and pharmaceutical schools of Tehran University of Medical Sciences (TUMS) stands at the highest rank followed by the websites of medical and pharmaceutical schools of Shiraz, Beheshti and Isfahan universities of medical sciences.

Zahedi *et al.* [21] showed that the archive of Iranian medical websites had the highest number of internal links, 30% of which being produced for re-



**Figure 1** Radar plot of the weighted scores of hospital websites. Each color corresponds to a particular university of medical sciences. The area is proportional to the weight scores.

search purposes. Aminpour and Otraj [22] showed that the top Iranian universities of medical sciences had not an effective web presence and their websites were not known at the international level. The low number of English web-pages and the immaturity of the Iranian academic websites were identified as the major reasons for the weak web presence of these medical universities.

Link analysis of websites in health and medical domains for measuring their visibility, contribution, and impact and identifying a core set of high impact websites is of great importance. To date, no independent study for the ranking of Iranian hospital websites has been conducted. In this study, the hospitals affiliated with Iranian Ministry of Health and Medical Education (MOHME) were targeted for a ranking effort. We expect that the results of this study provide further motivation for hospital administrators to demonstrate a more effective presence on the web.

## Methods

The websites of all hospitals affiliated with the MOHME were surveyed. The unit of analysis in this study is the

organization domain; only the hospitals with independent web domain have been investigated. If a given hospital has more than one website, each of them is considered as a separate website. The hospitals' names and Uniform Resource Locators (URLs) were obtained from the MOHME website. Further investigation showed that many of the dependent hospitals had independent websites not mentioned on the MOHME site. In some cases, the hospitals' URLs were not even cited in the website of the holding medical university. In such cases, the Internet was extensively explored to find the websites of these hospitals, when possible. The URLs of some hospitals such as the Jesus son of Mary Hospital and Goldis Hospitals (that were not included in the MOHME website) were found by investigating the website of the holding medical university and added to the list. In addition, the URLs of some hospitals such as Emdad Shahid Beheshti Hospital and Taleghani Hospital were updated.

Due to the mentioned problems, the hospital data collection was carried out in three turns and in each turn, some modifications were introduced. The hospitals with no identifiable URL or those with zero values of all webometrics

**Table 1 Top 20 Iranian Hospital Websites**

University of Medical Sciences	Hospital	Size rank	Visibility rank	Richness rank	Total Rank
Tehran	Farabi	4	1	5	1
Tehran	Tehran Heart Center	10	3	2	2
Tehran	Shariati	1	5	13	3
Beheshti	Mofid Children's	3	10	3	4
Shiraz	Namazi	7	8	13	5
Isfahan	Isabn-e-Maryam	15	6	13	6
Mashhad	Ghaem	6	10	13	7
Shiraz	Shahid Faghihi	9	15	4	8
Tehran	Children Medical Center	30	4	13	9
Iran	Hasheminejad Kidney Center	8	16	7	10
Shiraz	OmidvarEwaz	34	6	13	11
Shiraz	Amir-al-momeninGerash	45	2	13	12
Isfahan	Alzahra	31	9	13	13
Shiraz	Hafez	19	14	13	14
Mashhad	ShahidKamyab	24	13	13	15
Shiraz	Chamran	32	12	6	16
Kermanshah	Imam Ali	11	20	13	17
Mashhad	ShahidHashemiNezhad	18	18	13	18
Kermanshah	Farabi	13	30	8	19
Kashan	Beheshti	27	23	13	20
Kashan	Matini	36	23	1	20

parameters were excluded from the study. Following the above-mentioned screening, the information of the remaining 93 hospital websites was gathered and used for calculating the webometric indices.

Standard webometrics recommend use of four measures for ranking indices of a particular website, including size, visibility, the number of rich files, and the number of articles [13, 24].

The Webometrics website (<http://www.webometrics.info>) suggests a number of indices for ranking the websites of universities and hospitals. While we used the same measures in our ranking study, Some adjustment in the weights of the indices were deemed necessary. The calculations were made according to the following measures:

1. Website size with the weight of 20% (Sa): the num-

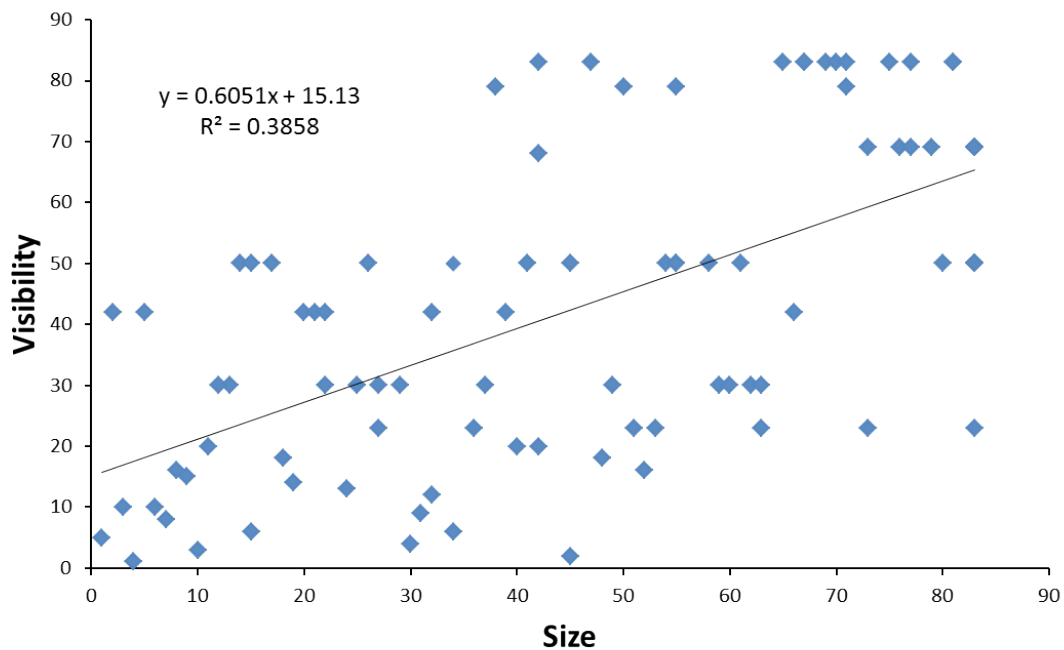
**Table 2 Correlations<sup>a</sup> between Hospital Websites' Size, Richness, and Visibility**

Variables	Size	Visibility	Richness
Size	1		
	1		
Visibility	0.621**	1	
	0.623**	1	
Richness	0.346**	0.336**	1
	0.308**	0.299**	1

<sup>a</sup> In each row, the upper value is the Pearson coefficient and the lower value is the Spearman coefficient.

\*\* Correlation is significant at 0.01 level (2-tailed).

ber of web pages in the URL identifiable by three major search engines, *i.e.*, Google, Yahoo! and Live Search.



**Figure 2** Scatter plot of size vs. visibility

Because the returning results from each search engine differ, the minimum and maximum numbers of the recovered pages were excluded, and the index was calculated based on the sum of the remaining values (Equation 1):

$$S_a = \frac{1}{2} \times (G_a + Y_a + L_a) - \max(G_a, Y_a, L_a) - \min(G_a, Y_a, L_a) \quad (1)$$

2. Visibility with the weight of 50% (V): the number of external links from other websites to each URL, reported by Yahoo! The results were further normalized in a logarithmic scale using the webometrics' normalization formula (Equation 2):

$$N_a = \frac{\log(n_a + 1)}{\log(\max(n_i + 1))} \quad (2)$$

where,  $n_i$  represents the search engine, and  $a$  refers to the domain of each website. The normalized values were compared for the ranking purpose.

3. The number of rich information files with the weight of 15% (R): the sum of number of all rich files with the file extensions of .ppt, .doc, .pdf, and .ps identifiable by the Google search engine (Equation 3):

$$R_a = pdf_a + ppt_a + doc_a + ps_a \quad (3)$$

4. The number of recovered articles by the Google Schol-

ar search engine with the weight of 15% (Sc): all reports, articles and web address citations could be found by Google Scholar.

Based on the calculated sub-indices, the overall webometric index of a hospital website can be calculated using the following formula (Equation 4):

$$WR = 50\% \times V + 20\% \times Sa + 15\% \times R + 15\% \times Sc \quad (4)$$

Since the published articles on the hospital websites were accessible from the websites of the holding medical universities, the index of number of recovered articles was considered zero for all hospitals. Also because the index of rich files was found to be non-zero only for 12 hospitals, it was excluded from the final formula. Pearson and Spearman coefficients were used for correlation analysis.

## Results

In total, the websites of 93 hospitals affiliated with 17 universities of medical sciences were surveyed. Figure 1 presents a radar plot of the weighted scores of the hospital websites.

Table 1 introduces the top 20 hospital websites according to our ranking. As seen, the three top-rank websites belong to the hospitals affiliated with Tehran University of Medical Sciences followed by



Beheshti and Shiraz universities of medical sciences. While the top 20 websites belong to hospitals affiliated with only seven medical universities among 17 surveyed, only five medical universities have representative in top 10 hospital website group. Most top 20 hospital websites have relatively low richness ranks. Both the first size rank and first visibility rank among all hospital websites was gained by two hospitals affiliated with TUMS. The highest richness rank was received by Matin Hospital affiliated with Kashan University of Medical Sciences.

On the other extreme, Babol, Ahwaz, and Hamedan universities of medical sciences have the websites of most their affiliated hospitals among the list of the lowest 10 rank. While these 10 hospital websites slightly differ in size, they share identical rank (the lowest among all) in terms of visibility and richness.

The complete list of hospital websites and their webometric ranks is given in the Additional File.

Table 2 presents the intercorrelations of webometric variables of the hospital websites, including size, visibility, and richness. As seen, webometric variables are significantly intercorrelated at 0.001 level.

Figure 2 shows the scatter plot and the results of regression analysis of hospital websites' size vs. their visibility. While both intuitive observation and regression results (both coefficient significant at 0.001 level; data not shown) suggest existence of a linear trend, size could not be used as a *precise* predictor of visibility, given the relatively small value of  $R^2$ .

## Discussion

The chief objective of this study was to rank the Iranian hospitals affiliated with MOHME. This ranking indicates the extent to which each hospital has successfully represented itself on the Internet. According to our analysis some hospitals affiliated with Tehran, Beheshti, Shiraz, Isfahan, and Mashhad universities of medical sciences gain the top 10 ranks. In general, the successful presence of these websites on the web can be attributed to possessing appropriate number of web pages (size) that influence their visibility through search engines, and thereby the number of received external links. Meanwhile, low richness of most hospital websites, even those among the top 20 group, leaves room for them to improve their overall rank by sharing more rich files on the web.

The observation that the top 20 hospital websites and the lowest 10 ones cluster into only few medical universities highlights the importance of support from

holding universities for active presence their affiliated hospitals on the web.

Our regression analysis identified a clear correlation between hospital websites' size and their visibility. This finding indicates an opportunity for hospital administrators to synergistically enhance their webometric ranks by increasing the size of their websites, as enlarging the website size would concomitantly result in an increased visibility as well.

During hospital data collection, we encountered a number of limitations which could be summarized as the following:

- 1-The URLs of many affiliated hospitals that had independent websites were not included in the MOHME's website.
- 2- The URLs of some hospital websites were not updated on the MOHME's website.
- 3- The websites of some hospitals are not included in the MOHME's website.
- 4- Several hospital websites did not have standard URL.
- 5- For some hospital websites, all webometric parameters were found to be zero.

Resolving these limitations can promote the visibility of hospitals' websites and thereby expansion of the number of users and external links, which in turn would lead to an improved indexing in public search engines.

Future research aimed at exploring the possible relationship between the performance of hospitals and their webometric ranks would result in interesting practical implications.

## Conclusions

Using webometrics methods, the present study provided a ranking for websites of Iranian hospitals affiliated with the Ministry of Health and Medical Education. This ranking can help hospital administrators to evaluate the strength of their on-line presence and plan to improve their status on the web. Our study found significant correlations between size, visibility, and richness of the hospital websites. In particular, regression analysis identified significant linear relationship between hospital websites' visibility and their. This finding indicates that hospital administrators can synergistically improve their webometric rank by increasing the size of their websites. The fact that the top 20 and the lowest 10 rank hospital websites cluster into a few medical universities highlights the importance of support from holding universities for active presence their affiliated hospitals on the web. This study also revealed a number of limitations during webometric analysis of hospi-

tal websites, including lack of standard URLs. These limitations can hinder a comprehensive ranking of all target hospital websites or decrease the ranking accuracy. Hence, hospital administrators and hospital holding universities need to address these limitations to enable straightforward and reliable evaluation of their presence on the web.

### Abbreviations

(TUMS): Tehran University of Medical Sciences; (MOHME): Ministry of Health and Medical Education; (URL): Uniform Resource Locator

### Competing Interests

The authors declare no competing interests.

### Authors' Contributions

PS conceived the study, coordinated the study procedure and contributed to interpretation of results and drafting the manuscript. BT was involved in data collection, data analysis and interpretation of the results, and drafting and revising the manuscript. AR participated in data collection, data analysis, preparation of the figures, and revising the manuscript. All authors read and approved the final manuscript.

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