

Abstract

Objective: With graphical mapping of a scientific field, it is facilitated to better and more accurately identify that branch of human knowledge and convert its abstract concept to a more objective concept. The aim of this study is to draw the thematic map of addiction articles.

Method: The present study was carried out with a scientific approach and falls within the category of applied research. The descriptors of the related articles were extracted with a search for the term «behavior, addictive» in the subject heading "mesh" of the PubMed website in the period of 2005 to 2014. The data analysis and map drawing were conducted by using Ucinet, Netdraw, and Ravar Matrix software.

Results: The growth of scientific production in the field of addiction has witnessed an increasing trend throughout the period of the study. Considering the centrality indices, such concepts as disorders pertaining to substance abuse, smoking, tobacco, and so on are the most frequently used topics in this field.

Conclusion: The use of social network analysis indices in the analysis of scientific maps is effective. The new knowledge and insight gained through the analysis of thematic maps are of great help to policy-makers in this field to make appropriate decisions for the promotion of scholarly products.

Keywords: thematic map, addiction, co-word analysis, social network analysis, MEDLINE database

Thematic Map of Articles Pertaining to Addiction Using Social Network Analysis in MEDLINE Database

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Introduction

Drugs and narcotics are a problematic issue that eliminates the most important asset of a person, i.e. health, and is more considered as a pessimistic condition. According to the definitions provided by the United States of America, drugs have been derived from the word addict: "Addiction is a major chronic disorder that creates interference with rewards, memory, and other parts of the brain. These disturbances bring about physical, psychological, social, and psychological attributes in human beings" (West, 2013). The emergence of such states in humans causes them to turn to the use of a narcotic substance or the conduct of destructive behaviors in order to achieve reward (pleasure) or relieve pains. Drug use and abuse are among the most important psychological and social problems that can have adverse disadvantages for individuals, families, and cultures and may act as a serious obstacle to human development and growth. Nowadays, addiction has become a problem for public health and health around the world (Velasquez et al., 2007).

According to the estimates released by United Nations Office on Drugs and Crime, 3.4% of the world's population, or 4.7% of the population over the age of 15 years are drug abusers (Agha Yousefi, Safarinia, & Abbaspoor, 2015). The history of this phenomenon in Iran dates back to several hundred years ago (Ehsanmanesh, & Karimi, 1999). To date, a wealth of research has been conducted on the harmfulness of addiction, its effective factors, and so on. The number of scientific articles and the quality of connections among them in each field indicate the hot topics of that particular field and the importance of each topic. The publication of articles on addiction has grown dramatically over the past few decades. The growth of addiction research can be attributed to the greater recognition of the addiction problem and the increasing interaction of executive institutions with scientific institutions (Masoumi-rad, 2010). The study of the phenomenon of addiction is done in the form of medical sciences, psychology, and sociology; however, a review of the literature shows that the produced knowledge and scientific activities in the field of addiction, its prevention, and its treatment have been often more developed by researchers in medical sciences, and addiction issues have been influenced by medical sciences (Rahimi Movaghar et al., 2009). The importance of community health, the accumulation of scientific research, and the growth of research in the field of addiction the clarification of this phenomenon and proposal of solutions to this problem have all increased the need for the conduct of meta-analyses in this field. In other words, in order to obtain clear evidence for the treatment of and combating against addiction, it is necessary to investigate and identify the research domains active in this field since it can lead to the optimal use of community resources. Over the past few decades, the study of scientific maps as one of the most important aspects of scientific studies has assumed great importance in various scientific fields. The presentation of a macro picture on the status of the studies conducted in this area, the way different areas of

knowledge are interconnected, and the way these areas develop over time is the objective of scientific maps. With the graphical drawing of a scientific field, science drawings pave the way for a better and more precise identification of that branch of human knowledge and for the transformation of the abstract concept of the scientific discipline into a more objective concept. In scientific maps, the subject areas that are more connected are displayed in a smaller distance from each other; and the areas that are less related to each other are displayed at a larger distance from each other (Abedi Jafari, Abuyi Ardakan, & Aghazadeh, 2010). The subject of science maps originates from scientometric knowledge. In scientometrics, statistical and quantitative methods are used to determine the criteria for the growth and development of science and their levels of expansion and their impact on various human societies. Scientometrics is part of the branch of sociology that is used for scientific policy making and includes quantitative studies of scientific activities among the publications of that field of science (Hood & Concepcins, 2001).

The main reasons for the increased popularity of the visualization area of science should be sought out in its effective capabilities. In fact, the use of visualization techniques has improved and completed human assessments and judgments of science, accelerated access to results, and, eventually, produced new results whose accessibility will not be possible without using the contribution of this science and by relying only on human skills (Norouzi Chakli, 2011).

Therefore, this study identifies the existing gaps by investigating the research on addiction and, in this way, it leads to the promotion of future research, identifies pathologies, and prevents the conduct of parallel research in future works. Also, the current study helps researchers investigate research information with scrutiny and careful observation by drawing the links between these topics as a scientific map, while having solid theoretical foundations. Ultimately, the new knowledge and insights obtained through this approach will help decision-makers and decision-making institutions in the field of drug addiction. Over the past few decades, the study of scientific maps, as one of the aspects of scientific studies, has become very important in various scientific fields. Scientific maps can be drawn using various techniques and methods and can show the structure of a scientific field. Some drawings are based on co-citation and co-authorship, and some are on the basis of co-word analysis, which refers to the number of times the two keywords come together in a document. The co-occurrence of words was first proposed for drawing the dynamics of science (Sedighi, 2014). Various studies have been conducted on co-occurrence of words and analysis of researchers' social networks in different areas, such as the etiology of colon cancer by Mokhtari (2015), massage therapy by Mehdizadeh Maraghi, Nazari, & Minaei (2013); medical field by Shekofteh & Hariri (2013), the field of comparative literature by Ahmadi, Salimi' & Zangisheh (2013), as well as urban management by Abedi Jafari, Abouyi Ardakan, & Aghazadeh (2010); and

library and information science by Gore, Nordberg, Palmer, & Piorun (2009); social work by Horton & Hawkins (2010); electronic conductor nanocomposites by Lee & Su (2010); in complementary and comprehensive medicine by Donald (2014); cancer treatment by Xie (2015) and Hou, Mao, Zhao, & Du (2015); life cycle assessment (2015); and drug and alcohol issues by Rahimi Movaghar et al. (2009). The review of previous studies shows that there has been no independent research on the application of the co-occurrence of words in the design of the thematic structure of addiction. Therefore, this research seeks to identify and draw the research fields of this domain by means of the co-occurrence of words and to contribute to scientific policy making in this field. The current research aims at realizing the following major and secondary objectives. The primary objective of the present research is to draw up and analyze the scientific map of addiction in the PubMed website during the period of 2005-2014. The secondary objectives include the study of the growing trend of research topics in the field of addiction in PubMed, awareness of thematic tendencies (what issues have been investigated more at any time period), analysis of the thematic relations of this field as well as specification of the most important subject areas.

Method

Population, sample, and sampling method

The present study is a descriptive-analytical research that analyzes the content of texts with a scientific approach. The research population included all the scientific articles in the field of addiction between 2005 and 2014 in the international arena that was available on the date of the search (September 18, 2015). In the first stage, by searching for the term "behavior, addictive" in the subject heading "Mesh" and by limiting the search to the main topics of the Mesh (Major Topics), the desired keyword was searched on the database. For the conduct of this study, Medline database (i.e., Medical Literature Analysis and Retrieval System Online) has been used. Medline is one of the most popular open databases in the world, which is published by the National Library of the United States of America, and contains information on all medical and biological sciences. This database is freely open to the public by a tool called PubMed. PubMed is one of the search environments and retrieval sources in the field of medical science on the World Wide Web, which has been developed by the National Center for Information Biotechnology at the National Library of Medicine of America (Kamaloddini, Pejman, & Dorijani, 2013). Indexing its data is done based on the subject heading of the Mesh. Therefore, since the required data was obtained from PubMed website by searching in the subject heading of Mesh, the validity and validity of the tools used in this research are verified. After the extraction of all articles (4005 records) on 27/6/94, the data were extracted in Tab delimited-UTF8 and Notepad format and were transferred to Excel software. At this point, the keywords obtained from the articles were homogenized by the Check tags and the Stop Word introduced in PubMed. For

example, child, animal, adult, chemistry, etc., which were included in check tags, were deleted from the keyword circle. In the next stage, according to Bradford's law, the number of 185 keywords with the frequency of 27 and above was identified as the base words. These keywords were chosen as the main concepts, which will be the basis for further analysis in this research. By identifying the basic topics, the symmetric matrix of co-occurrence was developed using Ravar Matrix software. The co-occurrence symmetric matrix is a square that shows that each topic is shared by other topics in several articles. These matrices provide automated thematic analysis through methods, such as cluster social network analysis. In this research, hierarchical clustering method has been used. The number of rows and columns is equal to the number of selected concepts, and each of its element represents the number of times that two keywords related to the row and column have come together in one document. Thus, this matrix is symmetric. The elements on the main diameter of the co-occurrence matrix are equal to the total number of repetitions of that keyword in all documents. Table 1 shows an example of a five-to-five matrix.

Table 1: An example of a five-to-five matrix for the analyses

	<i>Adaptation Psychological</i>	<i>Adolescent behavior</i>	<i>Affect</i>	<i>Age factor</i>	<i>Alcohol drinking</i>
Adaptation	75	5	2	0	3
Psychological					
Adolescent behavior	5	159	2	11	8
Affect	2	2	90	1	10
Age factor	0	11	1	109	5
Alcohol drinking	3	8	10	5	200

First, the growth trend of publications in the field of addiction was determined using the results of data analysis. Then, the analysis of the information obtained from the maps was carried out by drawing the subject map of this domain by means of Ucinet software and Netdraw software. This software, designed by Borgatti, Everett, & Freeman at Harvard University, is one of the most comprehensive and most popular social network analysis software items. There are various indexes for analyzing the co-occurrence of words networks that can be used in scientific maps. Centrality is one of the important indexes in network analysis. According to Freeman, the measures of centrality are divided into three categories, namely closeness, betweenness, and degree centrality. The degree centrality is the simplest type of centrality wherein the value of each node is obtained by counting its neighbors. The number of neighbors is obtained based on the interfaces to which the node is connected. This measure is defined by the number of direct links existing in an operator. The degree centrality of node k or (p_k) is calculated by the following formula:

$$C_D(P_K) = \sum_{i=1}^n a(p_i, p_k)$$

In the above formula, n denotes the number of nodes available in the network; and $a(p_i, p_k)$ equals one if the two nodes p_i and p_k are interconnected; otherwise, it is zero. The betweenness centrality is the number of times that the node is located in the shortest path between the other two nodes in the network. The nodes with a high level of betweenness centrality play an important role in network connectivity, which is of great importance to the network and also plays an important role in the information flow in the network. The betweenness centrality of node k or (p_k) is calculated by the following formula:

$$C_B(P_K) = \sum_{i=1}^n \frac{g_{ij}(p_k)}{g_{ij}} : i \neq j \neq k$$

In this formula, (g_{ij}) is the shortest path between the connection p_i and p_j ; and $g_{ij}(p_k)$ is the shortest path between the connection P_i and P_j passing through p_k . Closeness centrality is the average length of the shortest paths available between the nodes in the network. The nodes with a high closeness centrality index are more powerful in the network, have a more central role in the network, and have more accessibility to other nodes. The closeness index of k or (p_k) is calculated by the following formula:

$$C_C(P_K) = \sum_{i=1}^n d(p_i, p_k)^{-1}$$

In this formula, $d(p_i, p_k)$ is the shortest connecting path of two nodes p_i and p_k .

Results

The results of data analysis indicated that the growth of scientific-related products on addiction has experienced an ascending trend in PubMed website from 1991 to 2014. The growth of related articles in this field has accelerated, especially in recent years in such a way that the number of articles has doubled in the last four years (2010-2014).

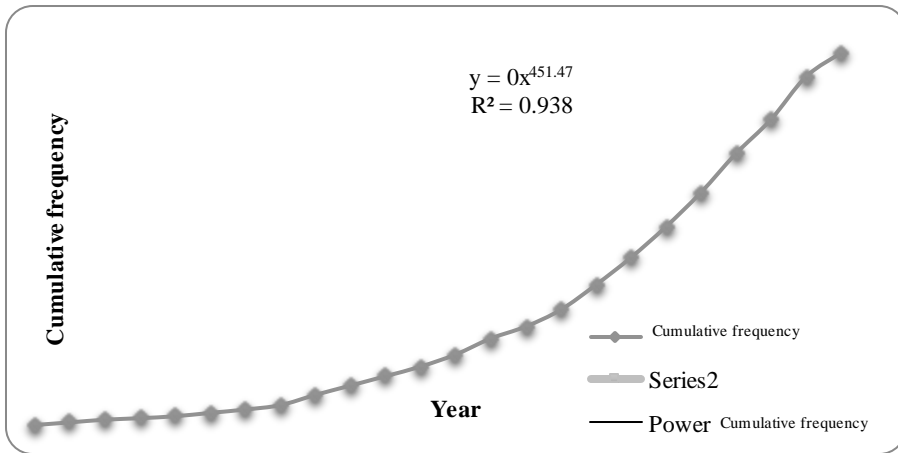


Chart. 1: Growth of articles related to addiction in PubMed database between 1991 and 2014'

Under the assumption that the keywords are content indicators indicating the subject matter, the most widely used terms, or some of the most active research fields associated with addiction were used from Bradford's law, which shows the distribution of the subject matter of the articles. In 1934, Bradford published a paper in which he described the distribution of co-authorship articles in scientific journals. He stated that a relatively small proportion of journals publishes a very high percentage of all articles in the same subject. According to this law, keywords can be divided into three categories: the core, near the core, and away from the core. Bradford's law is calculated according to the following mathematical relation where n is the number of core subjects and n_2 is the number of subjects near the core: $1: n: n_2$ (Hood, & Wilson, 2001). In this research, the first and second categories were identified as the most widely used words, which included 185 keywords with the frequency of 27 and above. In this section, only 34 widely used keywords are displayed in order to avoid the wrong display of the labels and the crowdedness of the chart.

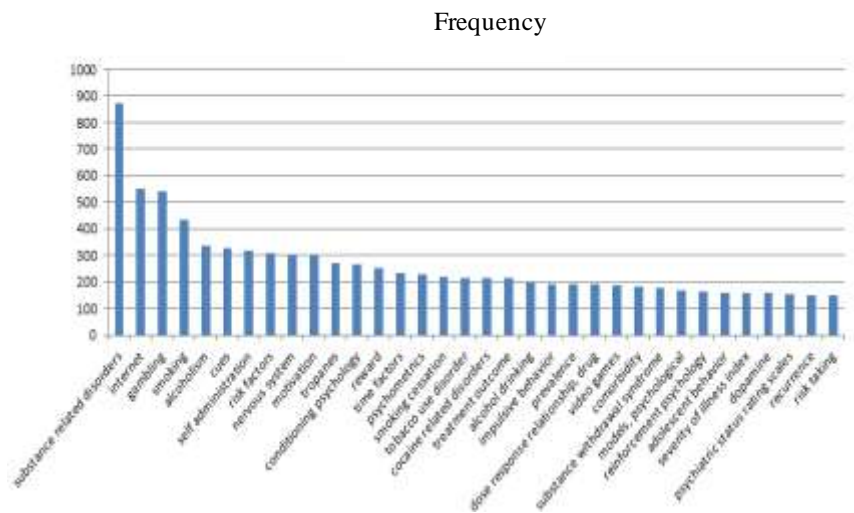


Chart 2: Frequency of core words in the addiction field from 1991 to 2014

As it has been shown in chart 2, "substance-related disorders, internet, and gambling" took up the highest rates of repetition in articles related to addiction among the core terms in PubMed database. In drawing of scientific maps, different types of categorization algorithms are used. One of the most important methods for classifying information is cluster analysis method (Abuyi Ardakan, Abedi Jafari, & Aghazadeh, 2010). The present study was conducted on 4005 articles related to addiction in the period of 1991–2014 where a total of 2303 keywords were obtained. Considering the average keywords in each article, which is about 5 words (the keywords may have been repeated in several articles), the number of keywords will decrease, but the frequency increases. Using Bradford's law, the core and near core topics (first and second categories) were selected from all the keywords, and 185 keywords with the frequency of 27 and above were selected. In the following, the co-occurrence map of these keywords have been focused.

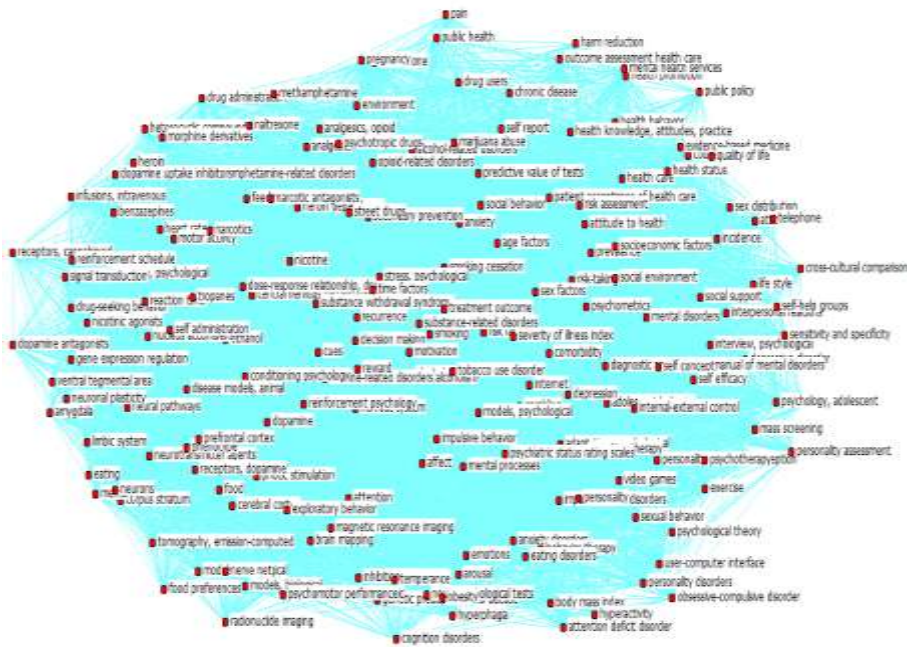


Figure 1 shows the co-word network of addiction words. In this image, each circle represents the keywords, and the lines represent the relationship between them. The co-word network is composed of 185 nodes (keywords) and 17596 lines (relationships between keywords). Because of the high number of lines relative to the nodes, the drawn network is continuous. As it can be observed in the image, the co-word network consists of only one large network. The lines of this network indicate that most keywords are interconnected directly or by intermediation. In order to better analyze the co-occurrence network of words related to addiction articles, the most widely used keywords with a closeness centrality other than zero have been identified and their co-word maps have been drawn. The concept of closeness centrality refers to the keywords that have been linked to other keywords with the minimum distance (the lowest number of links). The less the node's distance from the rest of the nodes, the better the node is. In fact, the node that holds a lower distance with other nodes will enjoy a higher influence and power.



Fig. 2: Overview of the co-occurrence network of addiction words in the 1991-2014 interval based on closeness centrality

The length of the diameter of the nodes (circles) in this image has an inverse relationship with the degree of centrality. This means that the smaller the diameter of the circles, the higher the closeness centrality; and the larger the diameter of the nodes, the lower the closeness centrality will be. In this image, the circles of the same size hold the same closeness centrality and have placed beside each other based on the closeness centrality. Table 2 lists the most effective keywords based on the closeness centrality index.

Table 2: Topics with a high closeness centrality pertaining to addiction in the 1991-2014 interval

No.	Keyword	Closeness centrality
1	Substance-related disorders	189
2	Motivation	192
3	Smoking	199
4	Alcoholism	202
5	Reward	204
6	Time factors	209
7	Nervous system	209
8	Tobacco use disorder	210
9	Risk factors	211
10	Treatment outcome	212

As it has been shown in Table 2, from 1991 to 2014, the keyword "substance-related disorder" with the closeness centrality of 189 ranked first, which was followed by motivation with the closeness centrality of 192, smoking with the closeness centrality of 199, alcoholism with the closeness centrality of 202, reward with the closeness centrality of 204, respectively. The betweenness centrality index is calculated based on the position of the words in the network.

When a word is placed between with the highest midpoint are the boundaries of a large number of nodes and the communication paths of other nodes pass through that word, it holds the highest betweenness centrality. The nodes with a high betweenness centrality play an important role in network connectivity, have a central position in the network, and play an important role in the information flow in the network (Abbasi, & Leydesdorff, 2012).

Table 2: Topics with a high betweenness centrality pertaining to addiction in the 1991-2014 interval

<i>No.</i>	<i>Keyword</i>	<i>Between's centrality</i>
1	Substance-related disorders	1.321
2	Motivation	1.188
3	Smoking	1.074
4	Alcoholism	1.030
5	Reward	0.949
6	Tobacco use disorder	0.887
7	Time factors	0.868
8	Treatment outcome	0.827
9	Nervous system	0.827

As it has been shown in Table 3, the keyword "substance-related disorders" with the betweenness centrality of 1.321 was ranked first and it was followed by motivation keyword with the betweenness centrality of 1.15 centrality, and smoking with the betweenness centrality of 1.074 in the second and third ranks, respectively. Figure 3 shows the co-word network based on the betweenness centrality. In this image, the diameter of the circles shows the betweenness centrality; therefore, larger circles hold a higher betweenness centrality than smaller circles.



Fig. 3: Overview of the co-occurrence network of addiction words in the 1991-2014 interval based on between centrality

The degree centrality is one of the indexes used in social network analysis. Generally, degree centrality refers to the degree of the links that a node has with other nodes in the network. The topic with the maximum number of lines has the highest degree and is the most central node (Soheili & Osareh, 2013).

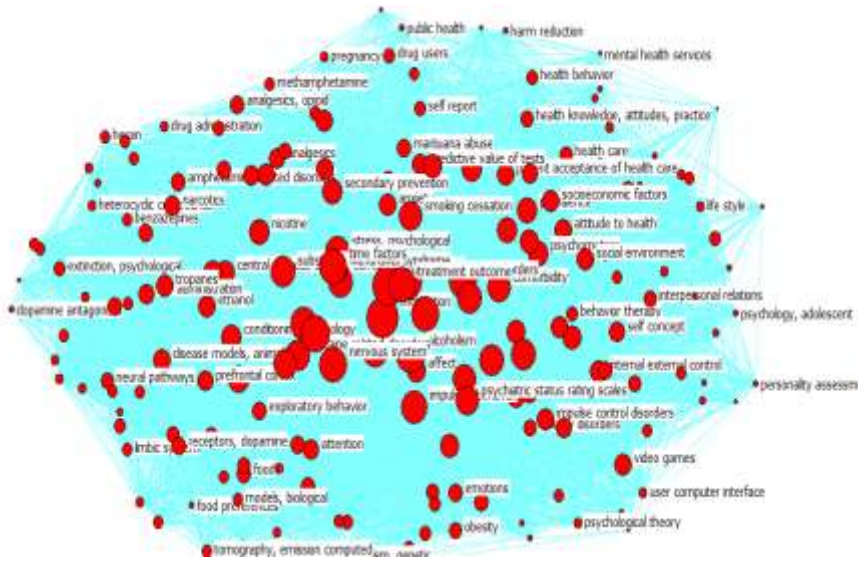


Fig. 4: Overview of the co-occurrence network of addiction words in the 1991-2014 interval based on degree centrality

There are 185 nodes or ninety and 17596 lines or links on the map. Larger circles indicate that they hold a higher degree centrality. These nodes are connected to each other by the lines that indicate the co-occurrence of each word with other words. As illustrated in Figure 4, "substance-related disorders", "addiction to gambling" and "addiction to the Internet" enjoy the highest degree centrality.

Discussion and Conclusion

The results of the data analysis indicate that the growth of scientific publications related to addiction that have been indexed on the Website of PubMed has experienced an ascending trend during the 1991-to-2014 period in such a way that the number of articles has doubled from 1991 to 2014. These findings are consistent with those of the research conducted by Rahimi Movaghar et al. (2009) in the field of addiction. In addition, the growth of scientific resources in other thematic areas has been confirmed in recent years. To exemplify, one can refer to the studies conducted by Hou et al. (2015) in the field of life cycle assessment; Makizadeh, Hazeri, & Keikhayi (2016) in the field of diabetes, and Makizadeh & Ebrahimi (2014) in the field of social trauma. A survey on the frequency distribution charts pertaining to the use of topics in addiction-related

documents through the PubMed website showed that this chart follows the Bradford's law and this helped with the identification of 158 widely used topics from 1991 to 2014. The findings of this research are consistent with the findings reported by Fatahi, Danesh, & Soheili (2011) who studied the global status of scientific productions of Ferdowsi University of Mashhad from 1990 to 2010 in the Web of Science with the aim of drawing the science map of this university. These findings are also consistent with those of the study carried out by Tavakolizadeh, & Ebrahimi (2014) who determined the main classes associated with knowledge management in the Web of Science.

According to Garfield, scientific citation maps are a unique method for studying the structure of science through which the research structure of specific domains can be drawn (as cited in Shekofteh, & Hariri, 2013). Therefore, the assignment of more attention to addiction maps and drawing them in different years can help with the identification of the most commonly used issues and the growing process of developments and progress of this area. In the drawn maps, according to the indexes of closeness centrality and betweenness centrality, one can argue that the highest value in terms of both indexes belongs to the thematic categories of "substance-related disorders, motivation, smoking, tobacco use, and alcoholism". These categories have an important position on the map in addition to being associated with a large number of other categories. An entity with a high closeness centrality has features, such as a higher effectiveness in the network, having a more central role in the network, and more accessibility to other nodes. An entity with a high betweenness centrality plays an important role in network connectivity, which has a central place in the network and plays an important role in the information flow in the network.

The betweenness centrality, as the structural attribute of the node, indicates the importance of the node in terms of its position in the map and in terms of information exchange in the network (Sedighi, 2014). The desirable and sound position of the topic of "substance-related disorders" in this study in line with other researchers' opinions is due to the fact that a description of abuse and dependence disorders opens up a new horizon in early prevention programs and considerably reduces the high treatment costs of abusive disorders (Babaei-asl, 2002). In addition, this indicates that the current intellectual paradigm in the field of drug-related issues is influenced by medical sciences, and this phenomenon is mostly seen as a form of physical illness. Medical sciences can enter into the field of addiction research only when drug abuse has occurred and, in fact, our knowledge is obtained after the occurrence of the event. The above scientific performance indicates that previous discussions, such as drug use prevention have not received the noticeable attention of the scientific field.

The high closeness centrality and betweenness centrality of topics, such as "smoking, tobacco use, and alcoholism" confirms that these issues have a great deal of effect on the relationship with other topics and are also related to other issues. Drug abuse, alcoholism, and tobacco use are among the main drugs that

are being abused. In addition, based on the gate hypothesis (the use of narcotics starts with the abuse of a soft drug and reaches a hard drug), smoking and alcohol consumption are considered as an introduction to other types of addiction. This finding of this study is consistent with that of the study conducted by Vanyukov who believes that smoking and alcoholism are important issues in the field of addiction, and suggests that these two issues should be targeted in prevention programs (as cited in Ehteshami, 2015).

The degree centrality refers to the status of an entity in a network (Freeman, 1979). An entity with a high level of degree centrality has a privileged position on the network, and is less dependent on other topics. In drawing the map with the degree centrality index, as observed, issues of substance-related disorders, gambling addiction, and Internet addiction hold the highest centralities (Figure 4). In other words, these issues were more influential in the network. However, other topic and issues are dependent on them while they themselves are independent at the same time. In line with this research, researchers in the field of addiction point to behavioral addiction to which Internet addiction and gambling belong (Knox, Daniels, Sturdivant, & Zusman, 2001; Andersen, 2001). Although behavioral addiction is a kind of addiction, it is categorized in a separate class, i.e. traditional addiction. Studies, such as the current one that investigate the general status of a field of science, are very useful in clarifying the state of that field. Considering that this research has used PubMed database to obtain resources, it is suggested that a research in this area be conducted through the exact methods of scientometrics on domestic databases and documents produced in Iran in order to compare its findings with those of the current research. Considering the presence of reputed researchers in the world in the field of addiction and the prevalence of addiction in Iran, the cooperation of national researchers with other researchers in the world is possible. The population of this study was PubMed articles which entails the conduct of discretion in the application of the results of this study.

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