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Scientometrics Analysis of Global Researches on Anemia

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ABSTRACT

Background: Anemia is a condition in which the number of red blood cells or the hemoglobin concentration within them is lower than normal. This study aims to show the intellectual structure of knowledge regarding anemia and gives a comprehensive and up-to-date image of research in this area.

Materials and Methods: This is a descriptive-analytical study with a scientometric approach. The PubMed database was searched for research publications indexed under "anemia" including 8484 records between 2011 and 2020. Data were analyzed using Co-word analysis, clustering methods, and strategic diagrams with the help of SPSS and Ucinet 6 software.

Results: The keyword "Anemia Sickle Cell" and two pairs of frequently used keywords, namely "Anemia, Iron *Iron" were the most frequent in the research area. The results shaped the concepts of anemia in 9 clusters. The clusters "Hydroxyurea and sickle cell anemia", "Fetus transfusion", "Management of Thalassemia Major", "Hemolytic Uremic Syndrome", "Management and Control of Anemia", "Chronic Kidney Failure and Anemia", "Hematopoietic Stem Cell Transplantation" are topics that may be emerging or disappearing. The "Thalassemia and blood transfusion" are immature clusters.

Conclusion: This study uses co-word networks that indicate important links between keywords of the research areas. Most research approaches are in the therapeutic aspects. Despite the importance of the effect of anemia on all levels of society, including economics, education, and other types of anemia, as well as its impact on learning and mental disorders, these subjects have not been given sufficient consideration.

Keywords: Anemia; PubMed; Bibliometrics; Co-word analysis

INTRODUCTION

Anemia is defined as a condition for red blood cells that their number as well as the concentration of hemoglobin is lower than normal. Hemoglobin is needed to carry oxygen and if you have too few or abnormal red blood cells, or not enough hemoglobin, the blood's ability to carry oxygen to body tissues is impaired. This leads to symptoms such as fatigue, weakness, dizziness and shortness of breath, among others. The most common causes of anemia include nutritional deficiencies, particularly iron deficiency, though deficiencies in folate, vitamins B12 and A are also important causes; haemoglobinopathies; and infectious diseases, such as malaria, tuberculosis, HIV and parasitic infections[1]. Anemia is a serious global public health problem, especially affecting young children and pregnant women. WHO estimates that 42% of children less than 5 years of age and 40% of pregnant women worldwide are anemic[2].

Biometrics is an interdisciplinary field of science that uses statistical methods to analyze a set of research papers in order to reveal the historical developments of the fields and uncover patterns of authorship, publication, citation, use and other relevant patterns[3]. Furthermore, it can provide insights into research clusters, current interests, and trends in emerging topics[4]. To control research output and

make effective scientific policies, bibliometrics or scientometric indicators have been widely applied for the evaluation of research performance in a wide range of scientific fields, including health topics and medical subfields[5].

For researchers to do meaningful and informed research, a comprehensive review study should be performed on anemia. In other words, the study of scientific production in anemia field can provide valuable reference and guidance for researchers in this field and to provide new insights and strategies for researches in this field. This study can help determine research direction, assign research funds, and identify gaps in research on anemia. The article surveys the major topics in anemia and reviews thematic relations using co-word analysis method. "The co-words analysis, as a scientometric method, helps us to study and identify conceptual relationships between scientific texts, to use such relationships to make general policies, and to choose research topics. This type of analysis can help us discover concepts, which are dominant in the works"[6].

Review the researches on topics clustering and co-word analysis shows that many studies have used co-word analysis, such as anticancer[7], medical big data[8], social media[9], medical big data[10], Linked Data Field[11] and andrology[12], laser[13] and medical sociology[14], and customer experience[15]. However, such research has not yet been conducted in the field of anemia.

It is notable that analyzing contexts on scientometrics researches about hematology topics has been done by many researchers, e.g., hematological research in five Islamic countries[16], anemia research in India[17], heredity blood disorder research[18], and iron deficiency anemia.[19]

This study, therefore, try to show the intellectual structure of knowledge related to anemia and gives a comprehensive and up-to-date image of research in this area. It is taken from PubMed from 2011-2020 by network analysis, co-word, and scientific visualization tools. In addition, annual publications of articles and journals in the field of anemia have been introduced.

MATERIALS AND METHODS

An academic search of the PubMed database (www.ncbi.nlm.nih.gov/pubmed) was done to retrieve papers, using the following keyword: "anemia"[MeSH Major Topic]), journal article [PT] and 2011:2020 [DP]". PubMed was chosen because it is a huge, reliable, and highly authoritative resource. It is specific to medicine and health. As PubMed is updated daily, data were extracted on date (August 7, 2021) to avoid possible biases.

Then, all the articles (8484 articles) were downloaded. The keywords from them were cleared with stop words and check tags. For example, female, infant, etc. and the keywords like history, methods, etc. were deleted from data. To avoid the influence of synonymy forms, all the keywords were examined and verified by an expert in the field. After that, according to Bradford's, 54 keywords with a frequency of 239 upwards were retained. Various thresholds for choosing the top keywords have been used in other researches[19,12]. The next step, the symmetrical co-occurrence matrix of the topics was formed by Ravar-PreMap software.

This matrix is square, indicating that each topic is shared with other topics in several articles. The presence of these matrices provides automated topic analysis through methods such as social network analysis and clustering. Finally, hierarchical clustering was performed using SPSS software (version 20), and the resulting dendrogram was analyzed. Afterward, for data analysis, the structure of anemia research was presented using UCINET and SPSS software in the form of a strategic diagram. Excel was used for the descriptive statistical analysis of the data. The network characteristics in the research include Degree Centrality, a measure of how many connections one cluster has to other sections of the network**.** In a network, if the cluster has a higher centrality, it stands in a basic status in the network. Centrality is applied to measure the connection degree between various topics[7], and Density, the assessment of a cluster's growth. A higher density means higher internal correlation degree among nodes. Density provides a good show of a cluster's capability to maintain itself and develop as time goes[7].

RESULTS

In general, 8770 articles were retrieved in the anemia field in PubMed from 2011-2020. During 2014-2020, it was in the rapid development stage.

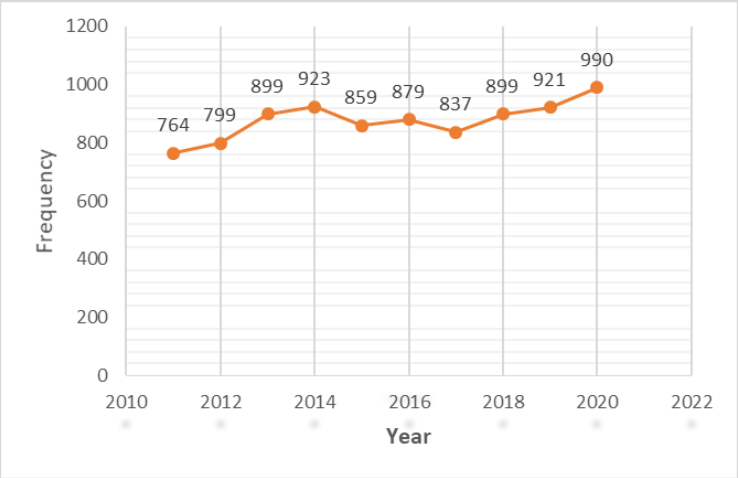

Figure 1. Time trend graph in anemia studies

Table 1: The top five journals of anemia filed

Number	Journals	Frequency	Percentage
1	PEDIATRIC BLOOD & CANCER	202	12.86
2	BLOOD	194	12.35
3	AMERICAN JOURNAL OF HEMATOLOGY	158	10.06
4	BRITISH JOURNAL OF HEMATOLOGY	154	9.8
5	JOURNAL OF PEDIATRIC HEMATOLOGY/ONCOLOGY	146	9.29

Output publication of this study was published in 1570 different journals. Table 1 displays, the top five journals that published papers (54.36%) on the field of anemia 2011-2020. Out of the articles retrieved, 54 keywords with a frequency of higher than 239 were selected from the total number of keywords (18,227 keywords). The Top keywords trend are seen in Figure 2. As seen, these key words have concepts such as “Anemia Sickle Cell”, “Anemia, Iron Deficiency”, etc.

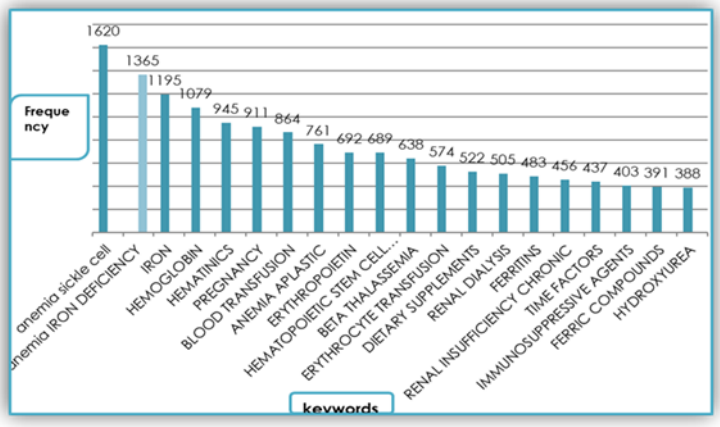

Figure 2. Top keywords trend graph

Analysis of co-word network

All the high-occurring keywords were converted into a co-occurrence matrix and were imported into the analysis and integration software Ucinet6.0 for sorting. Then, a visual network diagram was drawn to show the correlations between the high-occurring keywords. Circles, in the Figure 3, represent the keywords, and the lines show the relationship between them. The keywords seen with the most lines in the map naturally have the highest rank and the most central node.

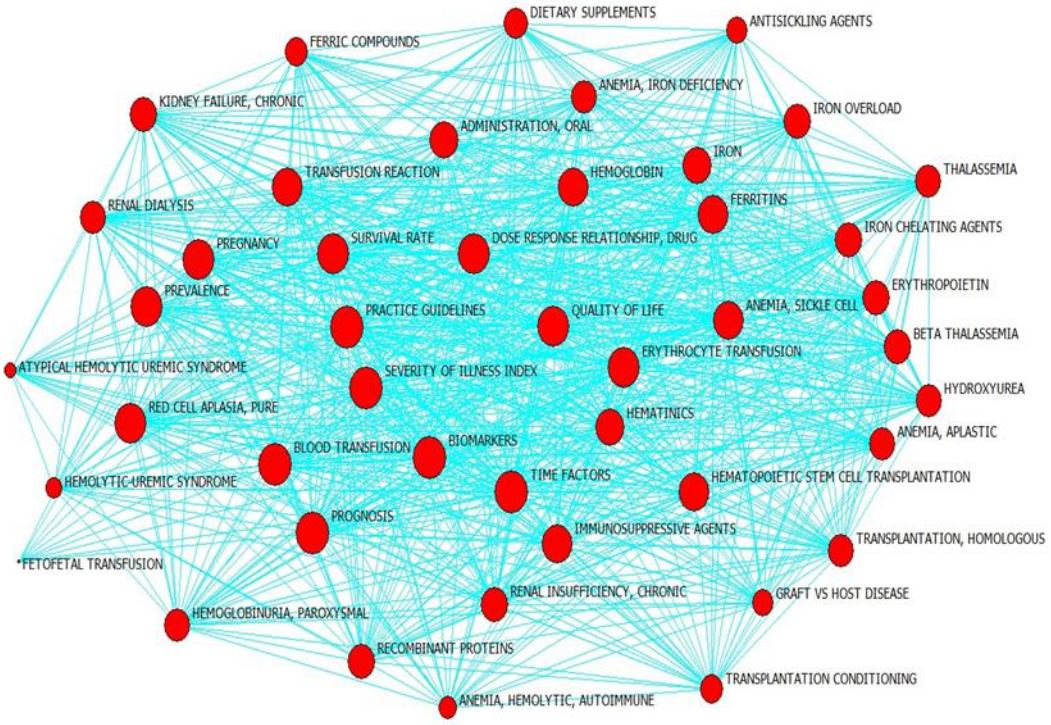

Figure 3. Co-occurrence anemia words network

In addition to showing the co-occurrence network in the field of anemia mentioned above, the most frequent pairs of anemia keywords were examined (Table 2).

Table 2: The Most frequent pairs of anemia keywords in order of frequency

Rank	Co- Words	Frequency
1	ANEMIA, IRON *IRON	711
2	ANEMIA, IRON DEFICIENCY*DIETARY SUPPLEMENTS	380
3	HEMOGLOBIN*HEMATINICS	360
4	ANEMIA, SICKLE CELL*HYDROXYUREA	342
5	HEMATINICS *ERYTHROPOIETIN	330
6	ANEMIA, IRON DEFICIENCY* HEMOGLOBIN	327
7	IRON* HEMOGLOBIN	311
8	PREGNANCY* FETOFETAL TRANSFUSION	308
9	ANEMIA, IRON DEFICIENCY* FERRIC COMPOUNDS	306
10	IRON* DIETARY SUPPLEMENTS	295
11	HEMATINICS* RENAL DIALYSIS	283
12	ANEMIA, APLASTIC* HEMATOPOIETIC STEM CELL TRANSPLANTATION	274
13	ANEMIA, IRON DEFICIENCY* PREGNANCY	266
14	HEMATINICS* RENAL INSUFFICIENCY, CHRONIC	262
15	ANEMIA, APLASTIC* IMMUNOSUPPRESSIVE AGENTS	259
16	ANEMIA, IRON DEFICIENCY* HEMATINICS	257
17	ANEMIA, IRON DEFICIENCY* FERRITINS	257
18	ANEMIA, SICKLE CELL* ANTISICKLING AGENTS	254
19	IRON* FERRITINS	231
20	ANEMIA, SICKLE CELL* ERYTHROCYTE TRANSFUSION	151

The keyword "university" is also used in combination with other keywords. According to Table 2, the pairs of co-words, "Anemia, Iron and *Iron" have the highest co-occurrence in this period of time. In general, it can be said that keywords such as "Anemia, Iron Efficiency", Anemia, Iron" And "Iron" have received a lot of attention.

Multivariate statistical analysis

Figure 4 shows the topic dendrogram, where similar keywords are grouped together in one category, and the higher the relevance, the closer the words are to each other.

It can be easily seen that the publications related to anemia can be divided into nine main clusters. The formed clusters are presented as follows:

Cluster 1: Hydroxyurea and Sickle Cell Anemia

Three keywords formed this cluster: “Hydroxyurea”, “Anticycling Agents” and “Anemia, Sickle Cell". This cluster is related to hydroxyurea and sickle cell anemia.

Cluster 2: Thalassemia and Blood Transfusion

This cluster includes six keywords, namely "beta thalassemia blood transfusion", "transfusion reaction", "thalassemia”, and … which indicates that this luster is related to thalassemia and blood transfusion.

Cluster 3: Fetus Transfusion

Cluster 3 includes two keywords, namely "pregnancy" and "fetofetal transfusion", which can be referred to as the fetus transfusion.

Cluster 4: Dietary Iron Bioavailability

This cluster is composed of the keywords "dietary supplements", "biomarkers" and "administration, oral". The name of this cluster was chosen according to the mentioned keywords.

Cluster 5: Hemolytic Uremic Syndrome

The "hemolytic uremic syndrome” and “atypical hemolytic uremic syndrome” are the keywords of the cluster that are focused on hemolytic uremic syndrome.

Cluster 6: Management and Control of Anemia

"severity of illness index" "survival rate "prognosis erythrocyte transfusion" and "practice guidelines " are most important keywords in this cluster, which is referred to as management and control of anemia.

Cluster 7: Iron Deficiency Anemia

With keywords "anemia, iron deficiency”, and "iron", this cluster can be referred to as iron deficiency anemia.

Cluster 8: Chronic Kidney Failure and Anemia

This cluster consists of 6 keywords. The "hemoglobin","hematinics","renal dialysis", "kidney failure, chronic", "erythropoietin" and "recombinant proteins". These keywords indicate that this cluster is related to hematopoietic factors and kidney dialysis.

Cluster 9: hematopoietic stem cell transplantation

This cluster is also composed of 6 keywords", "transplantation conditioning", "graft vs host disease", "transplantation, homologous", "hematopoietic stem cell transplantation “and "anemia, aplastic" that can be referred to as hematopoietic stem cell transplantation.

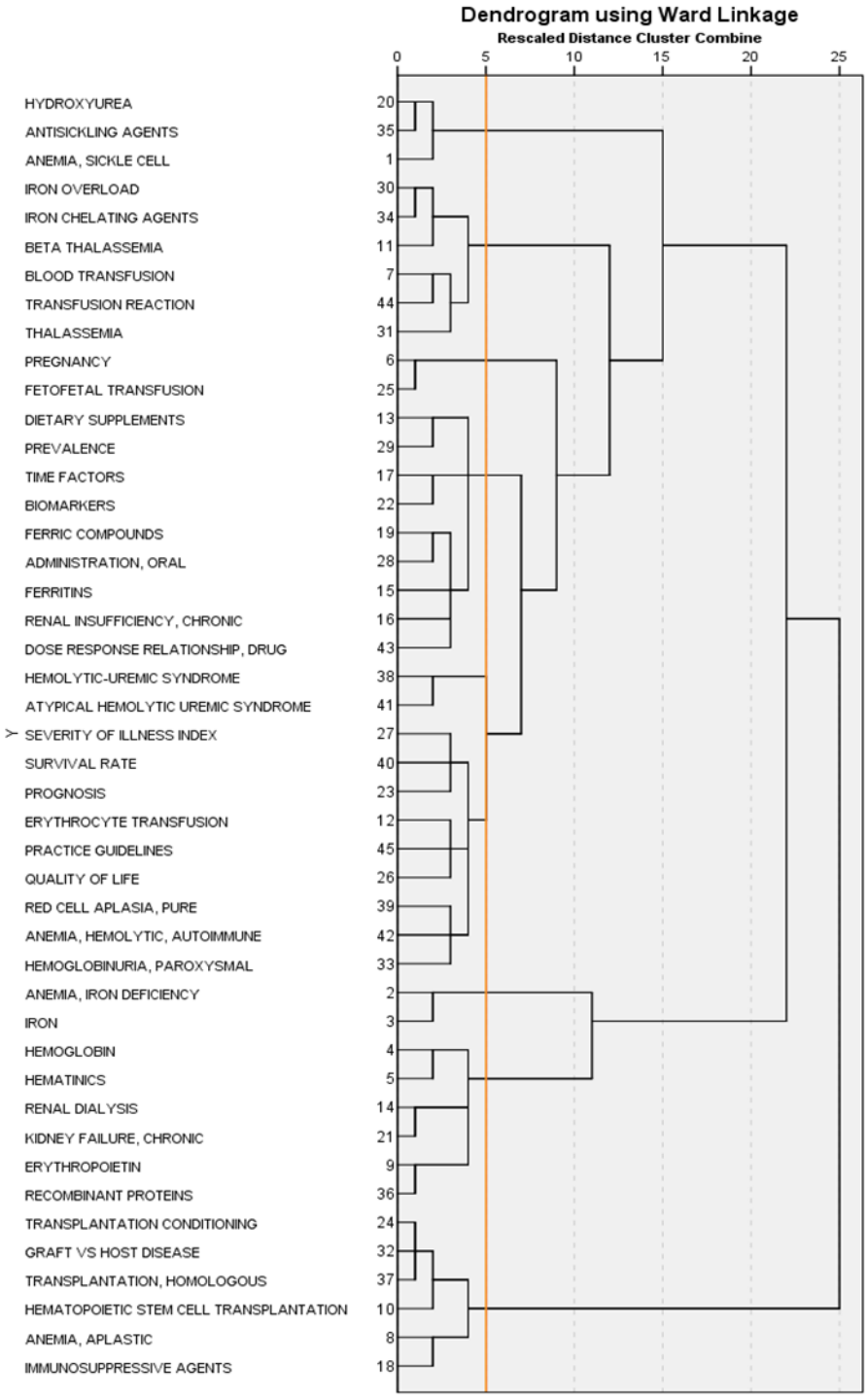

Figure 4: Clustering dendrograms in anemia field

Strategic diagram

Based on cluster degree and density of the 54 topics (9 clusters) in Table 3, a strategic diagram was built on external and internal cohesion of themes (Figure 5).

Table 3: Degree and density clusters resulting from co-word analysis

NO.	Clusters	Degree	Density
1	Hydroxyurea and sickle cell anemia	9.000	120.2
2	Thalassemia and blood transfusion	8.0000	200.33
3	Fetus transfusion	38.00	133.0
4	Management of thalassemia major	19.00	40.319
5	Hemolytic uremic syndrome	3333	1.5
6	Management and control of anemia	19.00	458.30
7	Iron deficiency anemia	7.000	693.0
8	Chronic kidney failure and anemia	3.000	533.180
9	Hematopoietic stem cell transplantation	11.00	333.14

As shown in Table 3, clusters 2 has higher degree. It shows that these clusters have combined well with other clusters of anemia and the cluster 8 has a lower degree. These are considered as marginal clusters of anemia.

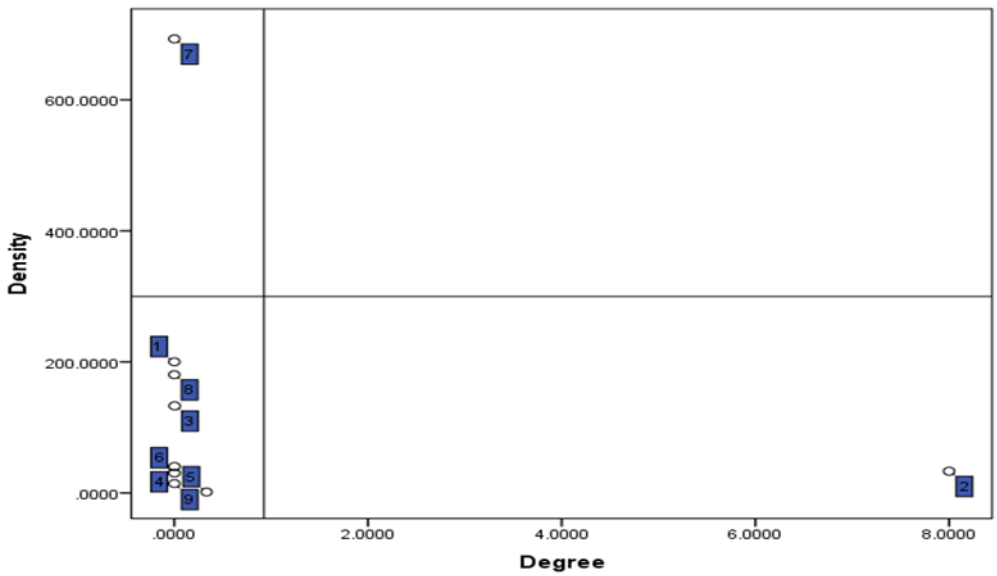

Figure 5. Strategic diagram of clusters derived from co-word analysis

The strategic diagram of the clusters derived from the co-word analysis in the field of anemia is shown in Figure 5. As indicated in Figure 5, the strategic diagram can be shown in four areas, each with a different centrality and density, and the clusters in those areas have different positions. In the figure, the horizontal axis shows the degree centrality, the rank and the power of interaction of each cluster. The more centered a cluster is, the more important the position of each cluster will be. On the other hand, the vertical axis shows the density and the internal relation in a particular research field.

In this study, the first area has no cluster. The density and degree of clusters in first area are high, indicating that this subject is well developed and has a powerful internal correlation and maturation. Therefore, the central topic of anemia has not appeared. In the second area of the diagram, only cluster 7 (Iron deficiency anemia) is located. It shows the cluster is not central; however, it is well developed. In the third area are the emerging or declining themes (clusters: 1, 3, 4,5,6,8 and 9). Low density and degree reflect that these clusters are weakly developed internally and often indicating that these topics are at the boundary of the field. Finally, the fourth area of the graph shows the cluster 2 (Thalassemia and blood transfusion) is basic and transversal which has a high degree of centrality and low density.

DISCUSSION

In this study, the methods mainly covered statistical, social network, hierarchical cluster, and strategic diagram analyses to identify major research themes and communities in the last 10 years and to understand how these communities and themes interact. The results of the study showed that in the field of spermatogenesis, from 2011 to 2020, the number of articles published continued to increase. As Price mentioned in his 1963 book "Little Science, Big Science", the number of scientific papers doubles every fifteen years. Such a growth in volume cannot be attributed just to one factor. Therefore, it can be concluded that such growth "is a part of scientific nature"[20]. About 54.36% of papers were published in five journals. These journals occupy the first position in the ranking of the oncology hematology in JCR (Journal Citation Reports).The results showed that the structure of the Co-word network of anemia and other thematic domains have formed a connected network in terms of network of intellectual structure, which in a way strengthens the intellectual structure of this field (Figure 2).

By analyzing the topics (keywords), a wide range of data was located in 9 clusters. The clusters created with common features within each group have structural relationships with each other and clusters. The main axis of the subjects was the Hematopoietic stem cell transplantation cluster. Hematopoietic stem cell transplantation is the most widely used cellular immunotherapy. The procedure involves the administration of hematopoietic stem cells to replace the recipient's hematopoietic system.[21] Hematopoietic stem cell transplantation is an established method for treating numerous malignant and certain benign conditions with the potential of cure.

According to the results of the strategic diagram from the co-word analysis in health communication, Cluster 7, Iron Deficiency Anemia, is located in Part 2, indicating that the cluster is not axial but well-developed. Iron deficiency anemia (IDA) as the most common nutritional deficiency in the world, with 30% of the population being affected with this condition[22]. Researchers seem to look at it differently because it is common and a multifactorial complication. Therefore, it is not the main issue, but there is a possibility of its development. Consistent with the present study, other studies have emphasized that Iron Deficiency Anemia needs to be investigated from many perspectives [19,22].

Notable results in the strategic chart are the presence of the clusters of "Hydroxyurea and Sickle Cell Anemia","Fetus Transfusion","Management of Thalassemia Major", "Hemolytic Uremic Syndrome"," Management and Control of Anemia","Chronic Kidney Failure and Anemia" and "Hematopoietic Stem Cell Transplantation" in section 3 of the chart, are under development. In other words, these clusters are marginal and have attracted little attention. Although these clusters contain frequently recurring topics, they seem to be among the main clusters. The reason for this is the relatively low density in this cluster, which indicates

the poor correlation of topics within these clusters. In line with this research, other researches that have examined the anemia field have not paid attention to the above issues and often talk about iron deficiency[19, 23, 24].

Another notable item in the strategic chart is the existence of the immature cluster "Thalassemia and blood transfusion". It can be concluded that researchers have not researched enough on topics related to this cluster. This result is consistent with the research of Shah et al.[25], which shows the research on this subject is growing, but the number of researchers is not large. The topics in this cluster have the ability to become the topics of the main clusters.

CONCLUSION

Based on the findings, in the field of Anemia, the most research approach was seen on the therapeutic aspects. In other words, the majority of research includes Blood Transfusion, Fetus Transfusion, Management and Control of Anemia, hematopoietic stem cell transplantation, etc. Despite the effect of anemia on all levels of society, including economics and education, other types of anemia and its impact on learning and mental disorders, these subjects have not been sufficiently considered. In addition, more studies, such as citation analysis or co-authorship in the field of anemia, are suggested. The above results provide new insights and strategies for the study of anemia and may have positive guiding significance for the study of hematology problems.

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CONFLICT OF INTEREST

None declared.

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