

# A Bibliometric Analysis of Global Research on Depression and Dry Eye Syndrome

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## Abstract

**Objective:** There is growing evidence that depression is associated with dry eye. Despite the lack of understanding of the specific causal relationship between depression and dry eye, depression has been shown to be a significant predictor of acute exacerbation of dry eye. In this study, we examine the evolution of the relationship between depression and dry eye over the past several decades and provide valuable insights into this topic. **Methods:** We searched the Web of Science Core Collection (WoSCC) from inception to December 31, 2023, for publications related to depression and dry eye. Trends in publications, authors, countries and institutions, and keywords were analyzed. **Results:** We extracted 259 publications from the WoSCC database. Since 2012, there has been a rapid increase in publications in this area. Among countries and institutions, the United States and the University of Manchester were the most prolific. In addition to 'depression' and 'dry eye', 'quality of life', 'anxiety', 'risk factors', and 'depression' have been identified. In addition to "depression" and "dry eye", terms such as "quality of life", "anxiety", and "risk factors" frequently appear in the titles and abstracts of articles. **Conclusion:** The study of depression and dry eye is booming, and the subject matter is becoming more in-depth as time goes on. This hot topic deserves more attention in the future.

## Keywords

Depression; dry eye; CiteSpace; VOSviewer; bibliometrics; visualization

## 1. Introduction

Depression is a common and serious mental disorder characterized by persistent sadness, loss of interest, fatigue, poor concentration, and low self-worth [1]. According to the World Health Organization (WHO), depression is one of the leading causes of disability globally and has a serious impact on the patient's daily life and ability to work [2]. Although the exact etiology of depression is not fully understood, a combination of genetic, neurobiological, psychosocial, and environmental factors are considered to be the main contributing factors [3]. Dry eye is a common ocular surface disease characterized by insufficient or rapid tear evaporation, resulting in dryness, burning, foreign body sensation, and blurred vision [4]. The etiology is complex, including insufficient tear secretion, excessive tear evaporation, blepharospasmal gland dysfunction, and environmental factors [5]. Dry eye syndrome not only affects the visual function of patients but also has a negative impact on their quality of life and psychological health.

In recent years, due to the high prevalence of depression and dry eye, it has long been recognized that there may be a possible interaction between depression and dry eye [6]. Depression can exacerbate the clinical status of dry eye, and the mechanical changes caused by dry eye can exacerbate the severity of depression. This bi-directional relationship suggests a strong link between mental health and ocular health, revealing complex pathologies that need to be

considered and managed in an integrated manner. Understanding the relationship between these two conditions and potentials is therefore crucial to their co-occurrence. Bibliometric analysis is a quantitative method of evaluating the characteristics and trends of research over a specific period of time by analyzing published academic literature [7]. In this way, we can identify research hotspots and emerging trends relevant to a particular field [8]. This study used bibliometric methods to analyze the overall status of research on depression and dry eye.

## 2. Materials and Methods

### 2.1 Data Sources and Search Strategy

The literature search was performed using the Web of Science Core Collection (WoSCC) from the time of creation to December 31, 2023, in English, with the following formula: [(TS=(depression)) OR TS=(depressive symptom)] OR TS=(depressive disorder) OR TS=(depressive syndrome) AND TS=(Dry Eye Syndrome) OR TS=(Dry Eye Diseases) OR TS=(Dry Eye Diseases) OR TS=(Dry Eye Diseases) (depressive disorder) OR TS=(depressive syndrome) AND [TS=(Dry Eye Syndrome)] OR TS=(Evaporative Dry Eyes) OR TS=(Dry Eye Diseases) OR TS=(Dry Eyes) OR TS=(Dry Eye) OR TS=(Evaporative Dry Eye Syndrome) OR TS=(Evaporative Dry Eye) OR TS=(Evaporative Dry Eye Disease) OR TS=(Dry Eye, Evaporative) OR TS=(Dry Eye, Evaporative) OR TS=(Dry Eye, Evaporative) OR TS=[(Dry Eye, Evaporative) Evaporative]] OR TS=(xerophthalmia) OR TS=(Dry Eye Disease). A total of 269 articles were searched, and 259 articles were included after removing conference papers and articles that did not meet the requirements after reading the abstracts. VOSviewer and Citespace were used to analyze the number of annual publications, authors, countries, and keywords of the included articles.

### 2.2 Data Analysis

Citespace software developed by Professor Chao-Mei Chen at American University can be used to visualize and analyze trends and patterns in the scientific literature to predict research trends in specific disciplines. In Citespace (version 6.1.R6), analysis parameters included a link retention factor of 3.0, a time span of 2013 to 2023 (one slice per year), node types of references and keywords, a range of intensities versus slices using cosine measurements, and a selection criterion of a g index scaling factor of 25. In addition, we used VOSviewer (version 1.6.16) to analyze the co-occurrence of countries, institutions, author distributions, and keywords, with burst detection for references generated by Citespace.

## 3. Results

### 3.1 Analysis of Publications

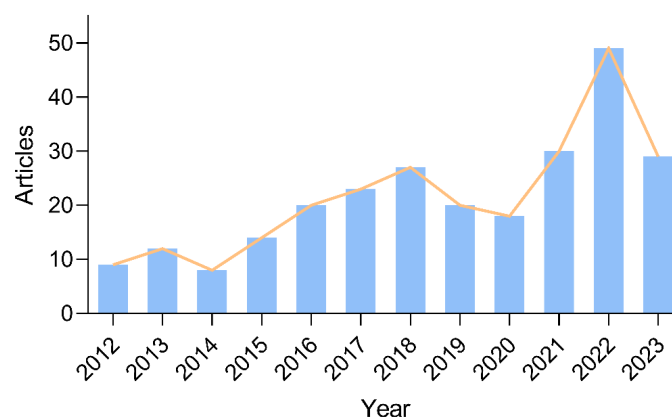
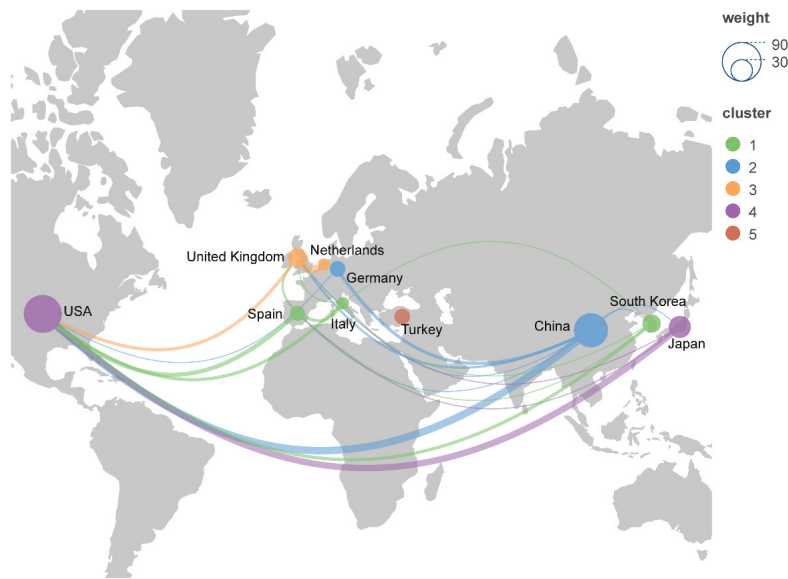


Figure 1. Annual trends in publications.

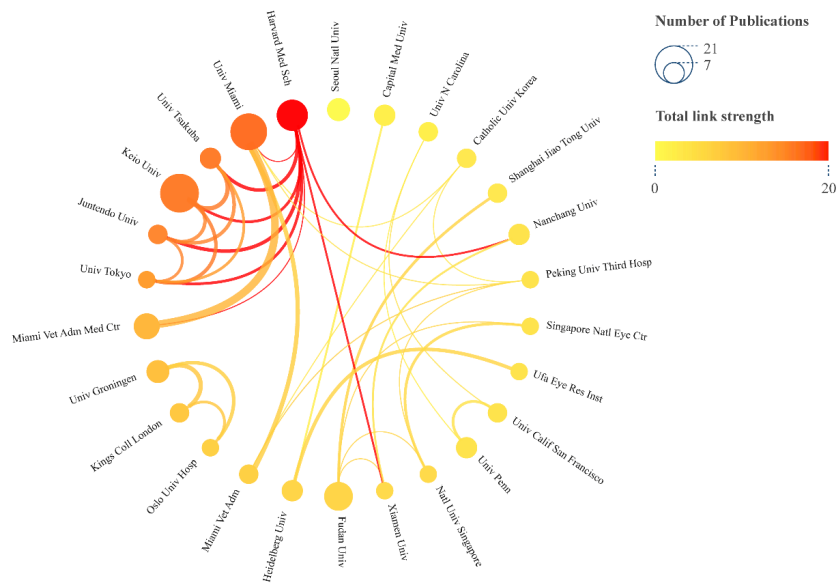
The earliest research on the link between depression and dry eye was conducted in 2012, and the number of articles published between 2012 and 2022 showed a general upward trend, reaching a peak of 49 articles in 2022, and a decline in 2023, but the number of articles is still high. This shows that researchers have maintained a high interest in this field in recent years. The trend of publications in recent years is shown in Figure 1.

### 3.2 Analysis of Countries/Regions

A total of 492 institutions in 41 countries co-authored 259 articles on depression and dry eye. Figures 2 and 3 show the top 10 countries and organizations in terms of productivity. The study shows that the United States is the country with the highest number of publications, followed by China and Japan. The most active affiliate was the University of Miami, followed by Harvard Medical School and Fudan University. The strength of our total linkage by country and institution indicates that the United States and the University of Miami are the most influential in this area.



**Figure 2. Geographic bibliometric map based on a network of co-authorship relationships in the top 10 countries in terms of number of articles published.**



**Figure 3. Institutions collaboration map.**

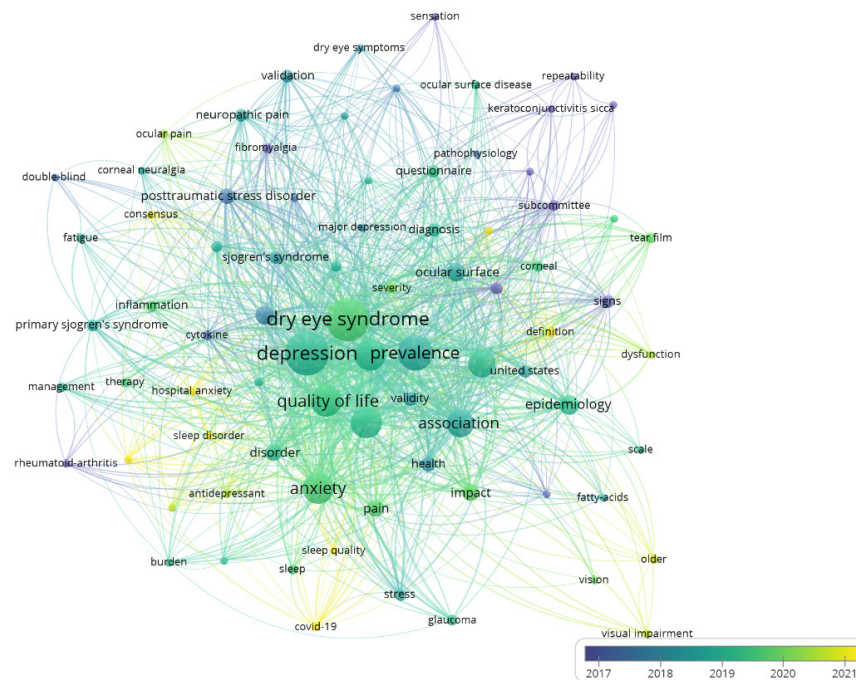
Figures 2 and 3 show the map of cooperation between the top 10 countries and institutions. The size of the nodes is related to the number of articles, and the width and color of the linking lines reflect the intensity of their cooperation.

The United States collaborates with a large number of countries, but most strongly with China. In addition, many research institutions, including the University of Heidelberg, Keio University, and Seoul National University, are actively involved in collaboration.

### 3.3 Keyword Co-occurrence Analysis

**Table 1. Top 30 most frequently occurring keywords**

Rank	Keyword	Count	Total Link Strength	Rank	Keyword	Count	Total Link Strength
1	depression	159	954	16	activation	40	227
2	dry eye syndrome	153	926	17	fibroblast-like cells	38	244
3	prevalence	104	679	18	mutation	36	174
4	symptomatology	82	600	19	neurotransmission	34	198
5	quality of life	82	599	20	gastrointestinal motility	34	174
6	anxiety	80	551	21	diagnosis	33	139
7	disease	80	527	22	muscle	33	139
8	association	63	445	23	identification	32	175
9	risk factor	62	423	24	guinea pig	31	173
10	epidemiology	32	329	25	currents	31	168
11	mouse	55	285	26	inhibitory neurotransmission	30	201
12	small intestine	53	314	27	slow waves	30	175
13	receptor	52	255	28	propagation	30	173
14	murine small intestine mechanism	43	245	29	channels	30	165
15				30	Ca <sup>2+</sup>	29	161



**Figure 4. Keywords co-occurrence visualization map.**

Keywords in an article indicate the subject matter of the article and can be used to identify hot spots and frontiers of research in a field [9]. A co-occurrence graph of 80 high-frequency keywords (more than 5 times) was constructed using VOSviewer software (Figure 4). The graph shows the change of keywords from 2012 to 2023, and the closer the color to yellow, the later the keyword appears. The table lists the top 30 keywords related to depression and dry eye. In addition to "depression" and "dry eye," "quality of life," "anxiety," and "risk factors" are also used, in addition to "depression" and "dry eye," terms such as "quality of life," "anxiety," and "risk factors" frequently appeared in the abstracts and titles of the articles.

#### 4. Discussion

In terms of the number of publications per year, research in the field of depression and dry eye reached a certain peak in 2022, after which the number of publications declined, but researchers still maintain a high level of interest. The United States is the most researched country in this field, and the figure shows that there is relatively close cooperation between most countries, but there is a lack of cooperation between Turkey and other countries. There is a lack of cooperation between institutions, with the University of Groningen, King's College London, and Oslo University Hospital not being connected to other institutions. Keyword analysis is the most valuable aspect of bibliometric analysis as it provides valuable information about the state of the art in a particular area of research. The most frequent keywords were related to depression and dry eye. The most frequent keywords were related to depression and dry eye and included epidemiology, symptoms, quality of life, anxiety, illness, associations, mechanisms, and diagnosis, as shown in Table 1. According to Figure 4, research in this area has been changing over time.

Labbé and his colleagues [10] explored the association between dry eye symptoms and depression in adults in a cross-sectional, population-based study. A sample of 1957 subjects was examined for symptoms of dry eye using questionnaires and ophthalmologic assessments, and 1,456 subjects were assessed for depressive symptoms using the Depression Scale in 2011. The results showed that the prevalence of depression was significantly higher in patients with dry eye than in those without dry eye (13.7% vs. 8.6%,  $P=0.02$ ), and depression scores were associated with dry eye symptoms ( $R=0.07$ ,  $P=0.013$ ). Multivariate regression analysis showed that dry eye symptoms were significantly associated with the risk of depression even after adjusting for cognitive status, area of residence, and body weight ( $P=0.028$ ). Depression was found to be significantly associated with dry eye symptoms, particularly dry eye symptoms, in an older population in Beijing. A cross-sectional correlational study by Jelle Vehof and partners [11] investigated the prevalence of dry eye in adults and its independent risk factors based on a study of 79,866 participants aged 20-94 years from the Lifeline Netherlands cohort. The results showed that 9.1% of the participants had dry eye, with the highest prevalence among 20-30 years old. Dry eye was associated with comorbidities in a variety of body systems.

In particular, depression was identified as a significant independent risk factor. In addition, being female, contact lens use, and a variety of health problems were also risk factors for dry eye. High blood pressure and high BMI were associated with fewer dry eyes, and dry eyes were more common in people who quit smoking. The study confirms and refutes the risk factors of many small epidemiologic studies, identifies many new risk factors, and highlights the significant association between dry eye and depression, suggesting the need to consider mental health factors when treating dry eye.

Li Meiyang et al. [12] studied 89 subjects with dry eyes and 73 controls using Self Rating Anxiety Scales (SAS), Self Rating Depression Scales (SDS), and Ocular Surface Disease Index (OSDI). The subjects were evaluated with the Self Rating Anxiety Scales (SAS), Self Rating Depression Scales (SDS), and Ocular Surface Disease Index (OSDI). The results showed that the SAS and SDS scores were significantly higher in the dry eye group than in the control group, and the prevalence of anxiety and depression symptoms was higher. It was also found that SAS scores were correlated with OSDI and education level and SDS scores were correlated with OSDI. It was concluded that anxiety and depression are associated with DES and need more attention and research. Together, these studies suggest that dry eye disease not only affects ocular health but is also closely related to broader mental health issues, suggesting that psychological factors need to be considered in the treatment of dry eye disease to improve the overall quality of life of patients.

It has been found that there is a co-morbidity between depression and dry eye and that both occur due to the interaction of multiple physiological and psychological factors [13]. The persistent discomfort and visual disturbances associated with dry eye may lead to depression and anxiety, while tear function and ocular surface health may be negatively affected in depressed patients. This finding emphasizes the importance of incorporating mental health assessments and interventions into the management of dry eye and suggests that healthcare professionals should pay

attention to the patient's psychological state in the management of dry eye in order to develop a more comprehensive treatment plan.

Despite important advances in current research, several limitations remain. First, most of the studies were cross-sectional and could not establish a causal relationship between depression and dry eye. Second, the assessment tools and diagnostic criteria used were not standardized across studies, which may affect the comparability of findings. Therefore, more longitudinal studies and randomized controlled trials are needed in the future to explore causality and underlying mechanisms.

Overall, this study reveals a significant association between depression and dry eye and emphasizes the importance of considering mental health in the management of dry eye. Through further research and multidisciplinary collaboration, the interaction between these two conditions can be better understood, thereby improving the overall health and quality of life of patients.

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