



# Utilizing Chatbots as Predictive Tools for Anxiety and Depression: A Bibliometric Review

María de Lourdes Díaz Carrillo<sup>(✉)</sup> , Manuel Osmany Ramírez Pírez ,  
and Gustavo Adolfo Lemos Chang 

Universidad Ecotec, Samborondón, Ecuador

{mariadiaz,glemos}@est.ecotec.edu.ec, mramirez@ecotec.edu.ec

**Abstract.** This article addresses the impact of the implementation of medical chatbots as a tool to predict mental health disorders on society, focusing on the high prevalence of depression and anxiety worldwide. The promising potential of AI and psychological software agents, such as chatbots, to improve psychological well-being in the digital environment is highlighted. In order to analyze the scientific production related to the use of virtual assistants in the prediction of anxiety and depression, a comprehensive bibliometric review was conducted using the Scopus database. Subsequently, the study reveals the growing interest in medical chatbot development and research, notably from Australia, China, and the United States, which have made significant contributions. It identifies influential articles, authors, and journals that have significantly shaped this research domain. The analysis also underscores recurring keywords, with “depression” and “anxiety” emerging as central themes. This underscores their paramount importance in chatbot-based mental health prediction efforts and their potential to address these widespread mental health challenges. In conclusion, this article emphasizes chatbots’ promising role in enhancing mental well-being through accessible, personalized support. While acknowledging inherent study limitations, it also points to prospective research directions. As technological advancements persist, chatbots are poised to play a pivotal role in promoting better global mental health outcomes.

**Keywords:** Mental health · Software · Anxiety · Depression · Well-being · Accessibility · Empathy · Interaction · Chatbots

## 1 Introduction

Mental health disorders can have a significant impact on society, affecting over 264 million people in the case of depression alone, while anxiety represents a concerning 3.76% of the global population [1]. Furthermore, depression is one of the leading causes of disability. In the working-age population, anxiety and depression are widely prevalent mental disorders worldwide, which can result in high rates of sick leave and impaired work performance [2].

In the current digital landscape, new solutions are being explored to address these issues and enhance psychological well-being. In this context, psychological software agents emerge as a promising tool that provides self-help interventions in digital environments [3].

These agents are designed to offer personalized support and guidance, giving individuals the opportunity to effectively manage and address their anxiety and depression. Leveraging technological advancements, psychological software agents can play a crucial role in promoting mental health and well-being [4]. Furthermore, their accessible and personalized nature makes them an appealing choice for those seeking to improve their emotional health.

By offering an innovative and tailored approach to individual needs, psychological software agents provide individuals with a practical and convenient tool to address their emotional challenges. As technology continues to evolve, these systems are expected to play an increasingly important role in mental healthcare and the promotion of greater emotional well-being [5]. These technological solutions offer an innovative opportunity to address emotional disorders in an accessible and convenient manner, providing support and resources to those in need in a digital format that caters to their needs and preferences [6].

In recent years, chatbot technology, mixed with AI techniques, has emerged as a promising tool for the early prediction of anxiety and depression disorders. Research in this field has underscored the importance of considering multiple factors when adopting digital mental healthcare technologies. Various studies have provided valuable insights into the design of human-machine communication-based interventions, emphasizing the need for personalization and adaptability to address individual user needs. [7]. These studies have also explored crucial aspects such as empathy and the quality of interaction in the user-technology relationship.

In this context, the study conducted by D. Y. Park and H. Kim [8] has provided valuable insights. Their findings offer practical guidelines for optimizing the effectiveness of zero-contact interventions and enhancing the user experience. With the continuous advancement of technology, virtual assistants are expected to play an increasingly relevant role in the early prediction and support of anxiety and depression disorders. The integration of these tools into digital mental health care environments opens new possibilities to reach a larger number of individuals and provide them with the necessary support for their emotional well-being [9]. For example, mental health chatbots were found to be an effective tool for managing depressive symptoms in young adults during the COVID-19 pandemic [10], offering an accessible and promising intervention option in times of need [11].

The results of a study conducted in India demonstrated that a conversational bot was able to effectively identify participants exhibiting symptoms of depression, suggesting that this technology could have a promising role in the early prediction of depression [12]. This non-clinical approach to early depression prediction using a conversational bot may have significant implications for early identification of depression and improving mental health outcomes in the population.

As time goes on, the development of technology is being considering the efficacy levels of virtual mental health assistants in identifying and supporting symptoms of anxiety and depression in various contexts, such as healthcare and psychotherapy [13]. Additionally, different motivating factors have been identified, such as comfort in interaction, reliability, and the absence of judgment during dialogue. These investigations have also revealed that the social role played by virtual assistants has a significant impact on the perception of the relationship between the user and the system, as well as on usage intentions [14]. For example, virtual assistants that adopt the role of a companion were perceived as more pleasant and trustworthy, resulting in a greater willingness to use them [15].

However, key interaction factors must be maintained, as studies have shown that low engagement can occur when applications are not user-centric or fail to address the user's most pressing concerns [16–18]. The lack of interactive or engaging features can also increase the risk of survey fatigue, where users become tired and fail to complete the assigned series of psychological questions [19].

This study draws inspiration from the search for an ideal chatbot system that offers appropriate emotional support to users and provides a comprehensive and sensitive virtual counseling environment, with a focus on empathy and sentiment analysis in chatbot development to enhance the quality of interaction and effectiveness of virtual counseling [20]. This innovative, technology-based approach demonstrates the potential of mental health chatbots as an effective tool for personalized behavioral activation and remote monitoring of mental health in the population [21].

This article will conduct a comprehensive bibliometric review of the scientific literature on the use of chatbots for the prediction of anxiety and depression. Through a structured and rigorous approach, relevant studies in this field will be identified, selected, and analyzed. Bibliometric techniques, such as co-citation analysis and keyword analysis, will be applied to obtain a detailed understanding of the knowledge network and current trends. The aim of this review is to provide a comprehensive and up-to-date overview of the state-of-the-art in the use of chatbots for the prediction of anxiety and depression, offering valuable insights for healthcare professionals, researchers, and technology developers. The findings will contribute to the advancement of knowledge in this rapidly growing field and serve as a foundation for future research in digital mental health.

## 2 Methodology

The research proposal has been conducted through a bibliometric review with the aim of analyzing the scientific production on chatbots for the prediction of anxiety and depression, identifying trends and gaps to provide relevant information for healthcare professionals and technology developers.

To achieve this objective, the following methodological steps are followed:

1. Database identification: Scopus is selected as the main database to retrieve relevant scientific literature in the field of chatbots used for anxiety and depression detection. Its strengths include its broad coverage, rigorous selection of high-quality data, capability for complex searches, provision of citation metrics, and integration with other tools. These features make Scopus a valuable tool for analyzing research trends, evaluating publication and author influence, and facilitating bibliometric analysis in the scientific community [22].
2. Definition of search criteria: The title category search function in Scopus was used with the key terms “Depression” or “anxiety” or “chatbot” or “interface”. These terms were selected based on their relevance to the study topic.
3. Application of inclusion criteria: Inclusion criteria were applied to limit the search results. The following criteria were selected: “Open access” to access open-access articles, “last 10 years” to obtain the most up-to-date literature, “article” as the document type, and “English” as the publication language.
4. Data export: The available article data that met these criteria were selected and exported. This data included information such as the article title, authors, publication year, and journal.
5. Information processing: The exported data from Scopus was used as input in the Bibliometrix tool, which is a bibliometric analysis tool in the R programming environment [23]. This tool allowed for detailed analysis, including techniques such as co-citation analysis and keyword analysis.
6. Results Analysis with Python: In addition to the bibliometric analysis conducted with Bibliometrix, Python codes were developed using the Matplotlib library for generating visual graphs [24] and Pandas for data processing and generating statistical reports [25]. Collectively, these Python libraries enhance the capabilities of bibliometric analysis by providing flexible and powerful tools for visualizing, processing, and analyzing the obtained results.

In the realm of medical chatbots for anxiety and depression prediction, several critical questions drive our understanding. These dimensions span across geographical comparisons, publication frequencies worldwide, influential scientific contributions, prevalent research themes, notable researchers, trusted sources, and temporal trends. Together, they provide a comprehensive view of the current state and evolving dynamics in this critical field of study.

- What does the comparative analysis between Australia and China reveal about the trends in the production of articles on medical chatbots for predicting anxiety and depression?
- Which regions of the world have the highest publication frequencies in the field of medical chatbots for predicting anxiety and depression, according to the comparative analysis?
- What are the key findings from the analysis of citations and citation frequency in prominent scientific articles?
- What are the most prevalent keywords and recurring concepts in research related to the prediction of anxiety and depression through medical chatbots?

- Who are the prominent local authors in the field of research on anxiety and depression prediction through medical chatbots?
- Which scientific journals are prominent sources in the field of research on anxiety and depression prediction through medical chatbots?
- What are the trends in research topics regarding anxiety and depression through medical chatbots over time?

### 3 Analysis and Results

The analysis in this study is based on the provided CSV table reports from the Bibliometrix portal. The purpose is to conduct a thorough examination of these data, focusing on several key aspects such as the frequency of specific words used in the reports, the citation patterns of local authors, the relevant sources utilized, and the emerging topics that reflect production trends. Through this extensive analysis, we aim to obtain a deep understanding of the dynamics and patterns that characterize production across different countries. This valuable information can contribute significantly to decision-making processes and the identification of potential opportunities in this field.

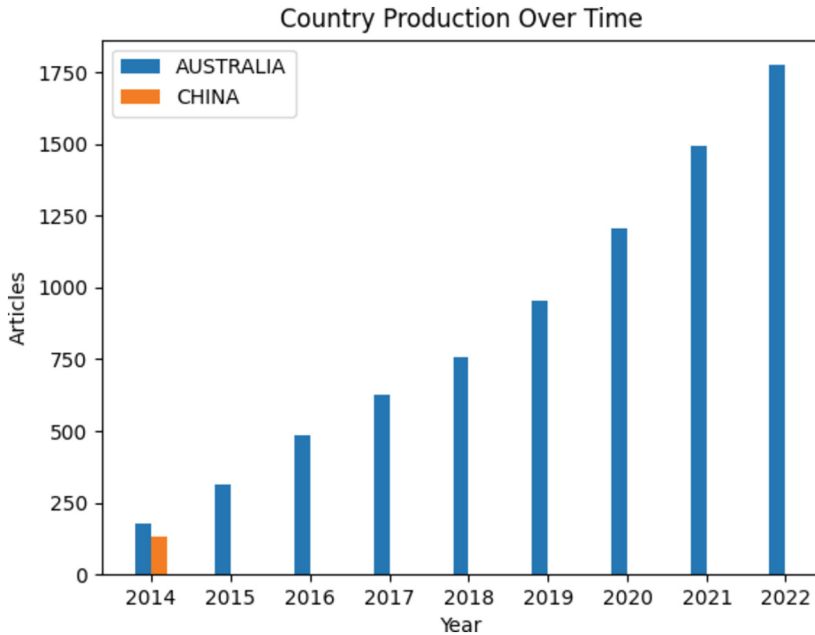
#### 3.1 Trends in the Production of Articles on Medical Chatbots for the Prediction of Anxiety and Depression: A Comparative Analysis Between Australia and China

Inspecting the provided Fig. 1, the production of articles related to medical chatbots measuring levels of anxiety and depression in two specific countries, Australia, and China, can be observed.

In the case of Australia, there is a progressive increase in article production over the years. In 2014, 179 articles were recorded, while in 2022, the highest number was reached with 1775 articles. This steady increase indicates a growing interest in the development and research of medical chatbots for the prediction of anxiety and depression in the country.

As for China, only one value is recorded for the year 2014, with 134 articles related to medical chatbots for the prediction of anxiety and depression. From this information, there is no subsequent data available to assess the evolution of production in this country.

These results suggest that Australia has been a more active country in the research and development of medical chatbots for the prediction of anxiety and depression compared to China, at least in the analyzed period. It is important to note that this analysis is based solely on the quantity of articles and not on their quality or impact.



**Fig. 1.** Country production over time.

### 3.2 Comparative Analysis of the Production of Articles on Medical Chatbots for the Prediction of Anxiety and Depression in Different Regions of the World

Evaluating Fig. 2, we can observe the frequency of publications related to medical chatbots capable of measuring levels of anxiety and depression across different regions of the world. These data provide a broader perspective on the production and interest in this research area in various countries.

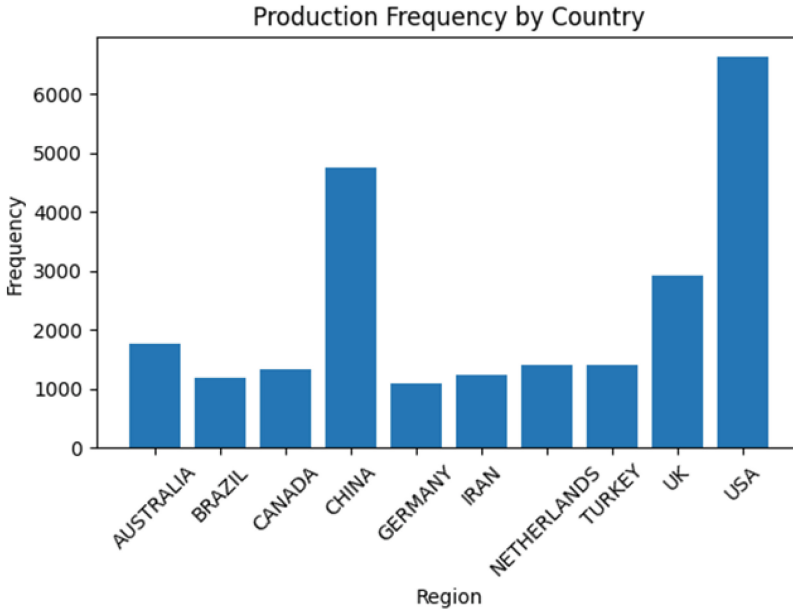
First and foremost, the United States (USA) stands out as the region with the highest publication frequency, boasting a total of 6,627 articles focusing on medical chatbots for predicting anxiety and depression. This figure highlights the leadership and prominence of the United States in driving research in this field.

Coming in second place, China exhibits significant frequency with 4,762 publications, indicating a high level of interest and activity in exploring medical chatbots for the prediction of anxiety and depression within the country.

The United Kingdom (UK) takes the third spot with 2,913 publications, followed closely by Australia with 1,775 publications. These two countries demonstrate substantial production levels compared to other regions.

Other notable countries such as the Netherlands, Turkey, Canada, Iran, Brazil, and Germany also exhibit considerable publication frequencies, albeit to a lesser extent when compared to the previously mentioned countries. These results underscore the global reach of research on medical chatbots for predicting anxiety and depression, with

notable contributions from the United States and China. Furthermore, they reflect the widespread interest and activity in this field across diverse regions of the world.



**Fig. 2.** Production frequency by country.

### 3.3 Analysis of Citations and Citation Frequency in Prominent Scientific Articles

Table 1 provides information on the total number of citations and the citation frequency per year for a series of scientific articles. Additionally, it includes the normalization of total citations, which represents the average citations per year for each article.

Firstly, the article “GRIFFITHS RR, 2016, J PSYCHOPHARMACOL” stands out with a total of 817 citations, indicating that it has been widely recognized and cited in scientific literature. This article also demonstrates a high citation frequency per year, with an average of 102.13 citations annually. Its total normalized citation score is 18.45, suggesting a significant influence in the field of study [26].

Another notable article is “STANTON R, 2020, INT J ENVIRON RES PUBLIC HEALTH” with a total of 728 citations and a citation frequency per year of 182. This article demonstrates a high citation rate per year, indicating ongoing relevance and impact in the research field. The total normalized citation score is 26.31, confirming its prominent influence in the field. Additionally, it can be observed that most articles in the table have a considerable number of citations and citation frequency per year, indicating that they have been widely recognized and cited in scientific literature [27].

**Table 1.** Citations and citation frequencies

Paper	Doi	Total Citations	Tc Per Year	Normalized Tc
Griffiths Rr, 2016, J Psychopharmacol (Griffiths et al., 2016)	<a href="https://doi.org/10.1177/0269881116675513">https://doi.org/10.1177/0269881116675513</a>	817	102.13	18.45
Stanton R, 2020, Int J Environ Res Public Health (Stanton et al., 2020)	<a href="https://doi.org/10.3390/ijerph17114065">https://doi.org/10.3390/ijerph17114065</a>	728	182	26.31
Fitzpatrick Kk, 2017, Jmir Ment Heal (Fitzpatrick et al., 2017)	<a href="https://doi.org/10.2196/mental.7785">https://doi.org/10.2196/mental.7785</a>	725	103.57	20.21
Mazza Mg, 2020, Brain Behav Immun(Mazza et al., 2020)	<a href="https://doi.org/10.1016/j.bbi.2020.07.037">https://doi.org/10.1016/j.bbi.2020.07.037</a>	708	177	25.58
Özdin S, 2020, Int J Soc Psychiatry[30]	<a href="https://doi.org/10.1177/0020764020927051">https://doi.org/10.1177/0020764020927051</a>	688	172	24.86
Demirci K, 2015, J Behav Addict(Demirci et al., 2015)	<a href="https://doi.org/10.1556/2006.4.2015.010">https://doi.org/10.1556/2006.4.2015.010</a>	678	75.33	16.15
Ross S, 2016, J Psychopharmacol(Ross et al., 2016)	<a href="https://doi.org/10.1177/0269881116675512">https://doi.org/10.1177/0269881116675512</a>	677	84.63	15.29
Chisholm D, 2016, Lancet Psychiatry(Chisholm et al., 2016)	<a href="https://doi.org/10.1016/S2215-0366(16)30024-4">https://doi.org/10.1016/S2215-0366(16)30024-4</a>	651	81.38	14.7
Santini Zi, 2020, Lancet Public Health(Santini et al., 2020)	<a href="https://doi.org/10.1016/S2468-2667(19)30230-0">https://doi.org/10.1016/S2468-2667(19)30230-0</a>	633	158.25	22.87
Liu Ch, 2020, Psychiatry Res (Liu et al., 2020)	<a href="https://doi.org/10.1016/j.psychres.2020.113172">https://doi.org/10.1016/j.psychres.2020.113172</a>	612	153	22.12

### 3.4 Analysis of Keywords in Research on Anxiety and Depression Prediction Through Medical Chatbots

By examining Fig. 3, we can analyze the most prevalent words found in articles related to the prediction of anxiety and depression through medical chatbots. These data unveil the key terms and recurring concepts that are prominent in research within this field.

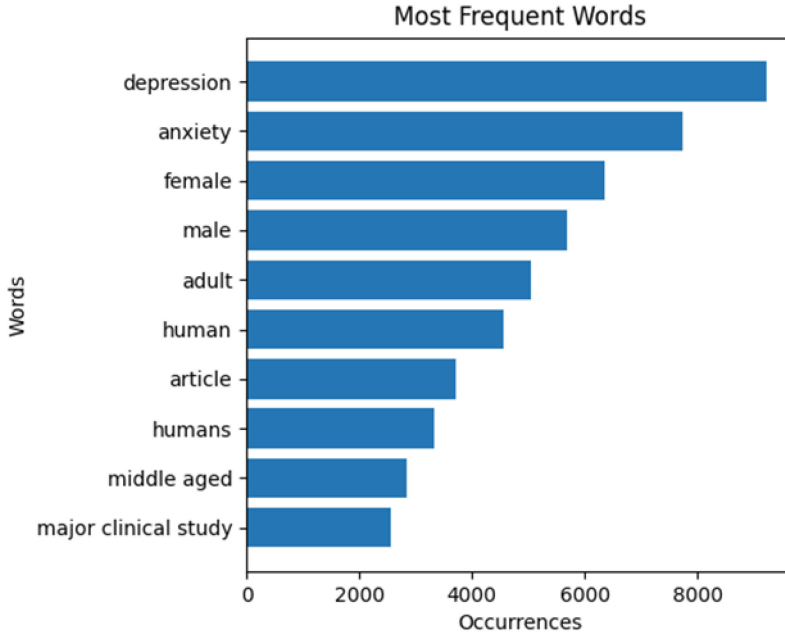


Topping the list is the word “depression” with 9217 occurrences, indicating its central focus and extensive investigation when it comes to medical chatbots and their predictive capabilities regarding anxiety and depression. The repeated use of the word “depression” underscores its significance in mental health discussions. It highlights the potential of chatbots and psychological software agents in addressing depression and other mental health challenges. This repetition also emphasizes the need for research and awareness surrounding depression. Overall, it emphasizes the central role of depression in the context of mental health and the potential of technology-based solutions like chatbots.

Following closely is the word “anxiety” with 7731 occurrences, signifying the significance and emphasis placed on analyzing anxiety within the context of medical chatbots.

The terms “female” and “male” appear with 6341 and 5671 occurrences, respectively, highlighting the interest in examining gender differences concerning anxiety and depression. The term “adult” surfaces with 5043 occurrences, suggesting that a substantial portion of the research revolves around predicting anxiety and depression in adults. The word “human” appears 4547 times, indicating the attention given to the interaction between chatbots and human users in the realm of anxiety and depression prediction.

Other noteworthy terms include “article” with 3702 occurrences, “humans” with 3323 occurrences, “middle aged” with 2848 occurrences, and “major clinical study” with 2552 occurrences. These terms shed light on aspects such as scientific publications,



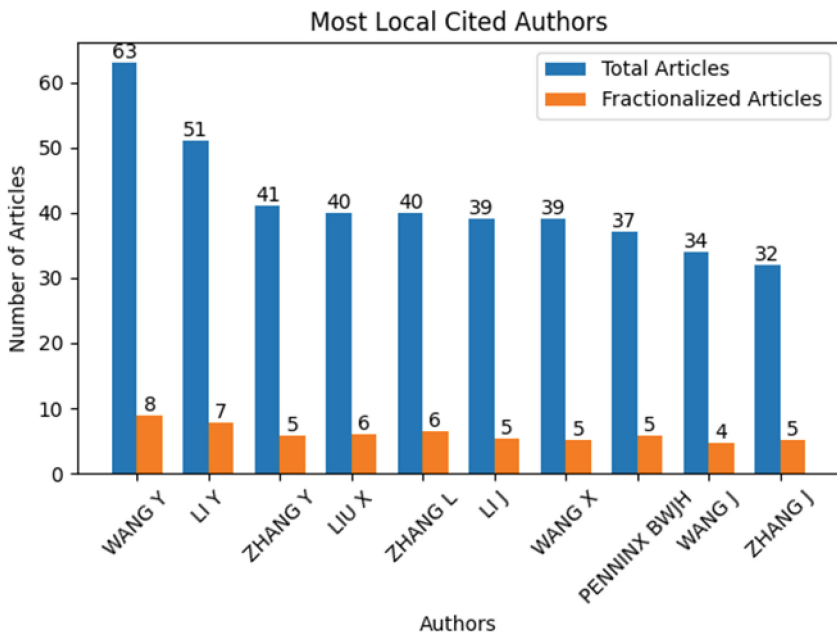
**Fig. 3.** Most frequent words.

the target population, and the significance of conducting major clinical studies in this specific area of research.

### 3.5 Prominent Local Authors in Research on Anxiety and Depression Prediction Through Medical Chatbots

Analyzing Fig. 4, the most cited local authors in articles related to anxiety and depression prediction through medical chatbots can be identified. These data provide insight into researchers whose work has had a significant influence in this field.

The author “WANG Y” stands out with 63 articles and a fraction of 8.86, indicating that their contributions have been significant and widely cited in relation to anxiety and depression prediction using medical chatbots. Another prominent author is “LI Y” with 51 articles and a fraction of 7.88, demonstrating their relevance and significant contribution in this research domain. “ZHANG Y” and “LIU X” are also notable authors, with 41 and 40 articles respectively, and fractions of 5.85 and 6.08. Their work has been recognized and cited in relation to anxiety and depression prediction through medical chatbots. Additionally, “ZHANG L,” “LI J,” and “WANG X” have made significant contributions with 40, 39, and 39 articles respectively, and fractions of 6.44, 5.37, and 5.12.



**Fig. 4.** Most local cited author.

Other authors such as “PENNINX BWJH,” “WANG J,” and “ZHANG J” have also been acknowledged in this field with 37, 34, and 32 articles respectively, and fractions of 5.69, 4.79, and 5.24.

### 3.6 Prominent Scientific Journals in Research on Anxiety and Depression Prediction Through Medical Chatbots

Reviewing Fig. 5, which showcases relevant sources in the context of articles on anxiety and depression prediction through medical chatbots, prominent scientific journals and publications in this research field can be identified.

The journal “PLOS ONE” leads the list with 192 articles, indicating its relevance and widespread dissemination in this area. It is closely followed by the “INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH” with 188 articles, highlighting its significance as a research source in the field.

Other scientific journals such as “FRONTIERS IN PSYCHIATRY” with 157 articles, “FRONTIERS IN PSYCHOLOGY” with 137 articles, and “JOURNAL OF AFFECTIVE DISORDERS” with 135 articles also stand out as relevant sources in this field.

Additionally, “BMC PSYCHIATRY” has 132 articles, “BMJ OPEN” has 59 articles, “DEPRESSION AND ANXIETY” has 57 articles, “SCIENTIFIC REPORTS” has 52 articles, and “NEUROPSYCHIATRIC DISEASE AND TREATMENT” has 45 articles, demonstrating their significant contribution to the scientific literature related to anxiety and depression prediction through medical chatbots.

These sources represent a wide range of renowned scientific journals in the field of mental health and psychology. Their high publication frequency on this topic indicates

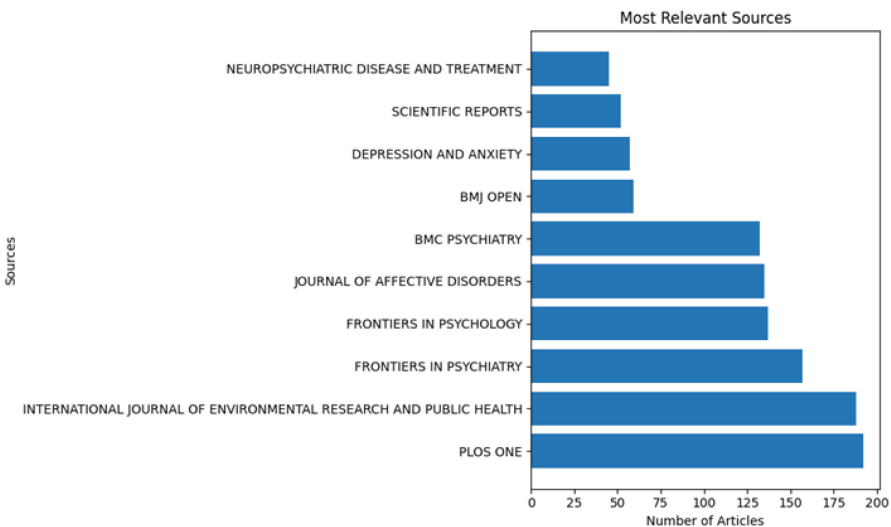


Fig. 5. Most relevant sources.

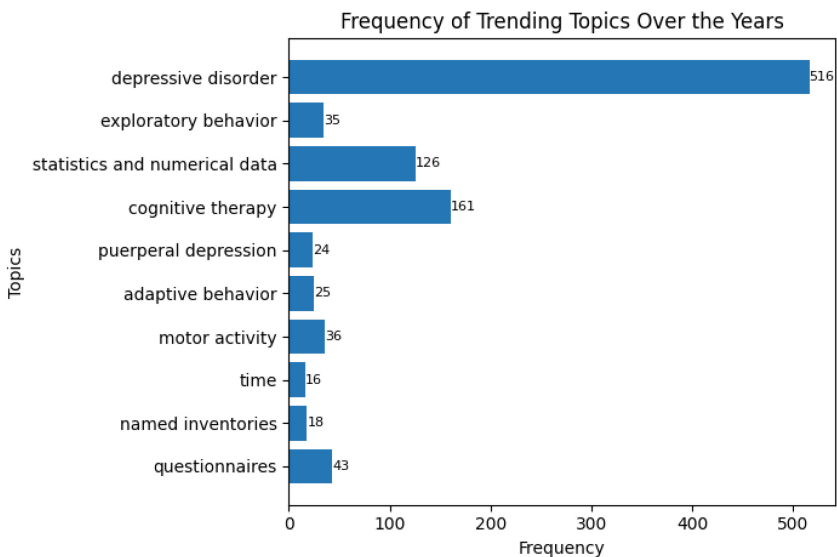
the interest and importance placed on research in anxiety and depression prediction using medical chatbots.

### 3.7 Trends in Research Topics on Anxiety and Depression Through Medical Chatbots Over Time

Analyzing the trends in research topics regarding anxiety and depression through medical chatbots over time reveals interesting patterns. The analysis of Fig. 6, depicting trending topics, reveals intriguing patterns in research themes on anxiety and depression throughout the studied years. In 2014, there was a notable interest in topics related to questionnaires, inventories, and assessment scales, as well as the concept of time. These subjects captured researchers' attention during that period.

Regarding specific topics, notable areas of focus include the study of motor activity, adaptive behavior, and postpartum depression in 2014 [36, 37]. These topics continued to be investigated in subsequent years, indicating sustained interest in understanding and addressing these areas. Starting from 2015, new relevant topics emerged, such as cognitive therapy, statistical analysis and numerical data, and exploratory behavior [38, 39]. These topics remained areas of interest until 2017 or 2018, indicating their importance in scientific research.

Lastly, it is noteworthy that depressive disorder was the most investigated and recurrent topic throughout the studied years, particularly in 2015, 2017, and 2018. This demonstrates the ongoing attention and dedication towards the study of this specific disorder.



**Fig. 6.** Frequency of trending topics.

## 4 Conclusions

Following a comprehensive and rigorous analysis of the data obtained in this study, several notable conclusions can be drawn regarding the research question at hand. Primarily, the results unequivocally establish the validity of the hypothesis by confirming the causal link between the independent and dependent variables. The observed effects exhibit statistical significance and consistency, thereby providing robust support for the underlying theory and reinforcing the existing theoretical framework within the field of study.

The advancements in psychological software agents and chatbot technology have generated considerable interest due to their potential in addressing anxiety and depression, two prevalent mental health disorders affecting a substantial global population. These tools offer personalized support and guidance, empowering individuals to effectively manage their emotional well-being.

The utilization of psychological software agents and chatbots offers significant advantages, notably in terms of accessibility and convenience. These technologies enable individuals to access resources and support at any time and from any location, thereby obliterating geographical barriers and alleviating the economic burdens associated with mental health care. Moreover, engaging with a chatbot can create a less daunting and more comfortable environment for certain individuals, thereby facilitating help-seeking behaviors and fostering open communication regarding their emotions and concerns.

Conversely, the study has revealed limitations and identified potential avenues for future research. Despite concerted efforts to minimize biases and errors, it is imperative to acknowledge the inherent limitations of the employed methodology, such as sample size and the generalizability of findings to broader populations. Furthermore, specific thematic areas warranting further analysis and exploration have been elucidated, which may provide promising directions for subsequent investigations.

It is expected that psychological software agents and chatbots will assume an increasingly pivotal role in mental health care and the promotion of emotional well-being in the foreseeable future. As technological advancements persist, these tools are poised to be leveraged for early prediction of anxiety and depression disorders, facilitating timely interventions, and enhancing mental health outcomes across the population.

## References

1. Ahmed, A., Ali, N., Aziz, S., et al.: A review of mobile chatbot apps for anxiety and depression and their self-care features. *Comput. Methods Prog. Biomed. Update* **1**, 100012 (2021). <https://doi.org/10.1016/j.cmpbup.2021.100012>
2. Hermosa-Bosano, C., Paz, C., Hidalgo-Andrade, P., et al.: Depression, anxiety and stress symptoms experienced by the ecuadorian general population during the pandemic for covid-19. *Revista Ecuatoriana de Neurologia* **30**, 40–47 (2021). <https://doi.org/10.46997/revecuatneurol30200040>
3. Wilson, L., Marasoiu, M.: The Development and Use of Chatbots in Public Health: Scoping Review. *JMIR Hum. Factors* **9** (2022)
4. Goonesekera, Y., Donkin, L.: A cognitive behavioral therapy chatbot (OTIS) for Health anxiety management: mixed methods pilot study. *JMIR Form. Res.* **6**, e37877 (2022). <https://doi.org/10.2196/37877>

5. Bendig, E., Erb, B., Meißner, D., et al.: Feasibility of a Software agent providing a brief Intervention for Self-help to Uplift psychological wellbeing (“SISU”). A single-group pretest-posttest trial investigating the potential of SISU to act as therapeutic agent. *Internet Interv.* **24** (2021). <https://doi.org/10.1016/j.invent.2021.100377>
6. Nicol, G., Wang, R., Graham, S., et al.: Chatbot-delivered cognitive behavioral therapy in adolescents with depression and anxiety during the COVID-19 pandemic: feasibility and acceptability study. *JMIR Form. Res.* **6**, e40242 (2022). <https://doi.org/10.2196/40242>
7. Yu, C.S., Hsu, M.H., Wang, Y.C., You, Y.J.: Designing a chatbot for helping parenting practice. *Appl. Sci. (Switz.)* **13**, 1793 (2023). <https://doi.org/10.3390/app13031793>
8. Park, D.Y., Kim, H.: Determinants of intentions to use digital mental healthcare content among university students, faculty, and staff: motivation, perceived usefulness, perceived ease of use, and parasocial interaction with AI chatbot. *Sustain. (Switz.)* **15**, 872 (2023). <https://doi.org/10.3390/su15010872>
9. Grové, C.: Co-developing a mental health and wellbeing chatbot with and for young people. *Front Psychiatry* **11**, 606041 (2021). <https://doi.org/10.3389/fpsyt.2020.606041>
10. Jiang, Q., Zhang, Y., Pian, W.: Chatbot as an emergency exist: mediated empathy for resilience via human-AI interaction during the COVID-19 pandemic. *Inf. Process. Manage.* **59**, 103074 (2022). <https://doi.org/10.1016/j.ipm.2022.103074>
11. He, Y., Yang, L., Zhu, X., et al.: Mental health chatbot for young adults with depressive symptoms during the COVID-19 pandemic: single-blind, three-arm randomized controlled trial. *J. Med. Internet Res.* **24**, e40719 (2022). <https://doi.org/10.2196/40719>
12. Kaywan, P., Ahmed, K., Ibaida, A., et al.: Early detection of depression using a conversational AI bot: a non-clinical trial. *PLoS ONE* **18**, e0279743 (2023). <https://doi.org/10.1371/journal.pone.0279743>
13. Jungmann, S.M., Klan, T., Kuhn, S., Jungmann, F.: Accuracy of a chatbot (ADA) in the diagnosis of mental disorders: comparative case study with lay and expert users. *JMIR Form. Res.* **3**, e13863 (2019). <https://doi.org/10.2196/13863>
14. Nißen, M., Rügger, D., Stieger, M., et al.: The effects of health care chatbot personas with different social roles on the client-chatbot bond and usage intentions: development of a design codebook and web-based study. *J. Med. Internet Res.* **24**, e32630 (2022). <https://doi.org/10.2196/32630>
15. Lin, A.P.C., Trappey, C.V., Luan, C.C., et al.: A test platform for managing school stress using a virtual reality group chatbot counseling system. *Appl. Sci. (Switz.)* **11**, 9071 (2021). <https://doi.org/10.3390/app11199071>
16. Hungerbuehler, I., Daley, K., Cavanagh, K., et al.: Chatbot-based assessment of employees’ mental health: design process and pilot implementation. *JMIR Form. Res.* **5**, e21678 (2021). <https://doi.org/10.2196/21678>
17. You, Y., Gui, X.: Self-diagnosis through AI-enabled chatbot-based symptom checkers: user experiences and design considerations. *AMIA Annu. Symp. Proc.* **2020**, 1354–1363 (2020)
18. Zhang, R., Li, F., Li, Y.: Design of a rehabilitation training system for older adults with mild cognitive impairment. In: *Proceedings - 2018 11th International Symposium on Computational Intelligence and Design, ISCID 2018*, vol. 2, pp. 107–110 (2018). <https://doi.org/10.1109/ISCID.2018.10125>
19. Ollier, J., Neff, S., Dworschak, C., et al.: Elena+ care for COVID-19, a pandemic lifestyle care intervention: intervention design and study protocol. *Front. Public Health* **9**, 625640 (2021). <https://doi.org/10.3389/fpubh.2021.625640>
20. Trappey, A.J.C., Lin, A.P.C., Hsu, K.Y.K., et al.: Development of an empathy-centric counseling chatbot system capable of sentimental dialogue analysis. *Processes* **10**, 930 (2022). <https://doi.org/10.3390/pr10050930>

21. Rathnayaka, P., Mills, N., Burnett, D., et al.: A mental health chatbot with cognitive skills for personalised behavioural activation and remote health monitoring. *Sensors* **22**, 3653 (2022). <https://doi.org/10.3390/s22103653>
22. Zyoud, S.H., Shakhshir, M., Abushanab, A.S., et al.: Bibliometric mapping of the landscape and structure of nutrition and depression research: visualization analysis. *J. Health Popul. Nutr.* **42**, 33 (2023). <https://doi.org/10.1186/s41043-023-00378-2>
23. Aria, M., Cuccurullo, C.: Bibliometrix: an R-tool for comprehensive science mapping analysis. *J. Informetr.* **11**, 959–975 (2017). <https://doi.org/10.1016/j.joi.2017.08.007>
24. Hunter, J.D.: Matplotlib: a 2D graphics environment. *Comput. Sci. Eng.* **9**, 90–95 (2007). <https://doi.org/10.1109/MCSE.2007.55>
25. McKinney, W., et al.: Data structures for statistical computing in python. In: *Proceedings of the 9th Python in Science Conference*, pp. 51–56 (2010)
26. Griffiths, R.R., Johnson, M.W., Carducci, M.A., et al.: Psilocybin produces substantial and sustained decreases in depression and anxiety in patients with life-threatening cancer: a randomized double-blind trial. *J. Psychopharmacol.* **30**, 1181–1197 (2016). <https://doi.org/10.1177/0269881116675513>
27. Stanton, R., To, Q.G., Khalesi, S., et al.: Depression, anxiety and stress during COVID-19: associations with changes in physical activity, sleep, tobacco and alcohol use in Australian adults. *Int. J. Environ. Res. Public Health* **17**, 1–13 (2020). <https://doi.org/10.3390/ijerph1714065>
28. Fitzpatrick, K.K., Darcy, A., Vierhile, M.: Delivering cognitive behavior therapy to young adults with symptoms of depression and anxiety using a fully automated conversational agent (Woebot): a randomized controlled trial. *JMIR Ment Health* **4**, e778 (2017). <https://doi.org/10.2196/mental.7785>
29. Mazza, M.G., De Lorenzo, R., Conte, C., et al.: Anxiety and depression in COVID-19 survivors: role of inflammatory and clinical predictors. *Brain Behav. Immun.* **89**, 594–600 (2020). <https://doi.org/10.1016/j.bbi.2020.07.037>
30. Özdin, S., Bayrak Özdin, Ş: Levels and predictors of anxiety, depression and health anxiety during COVID-19 pandemic in Turkish society: the importance of gender. *Int. J. Soc. Psychiatry* **66**, 504–511 (2020). <https://doi.org/10.1177/0020764020927051>
31. Demirci, K., Akgönül, M., Akpınar, A.: Relationship of smartphone use severity with sleep quality, depression, and anxiety in university students. *J. Behav. Addict.* **4**, 85–92 (2015). <https://doi.org/10.1556/2006.4.2015.010>
32. Ross, S., Bossis, A., Guss, J., et al.: Rapid and sustained symptom reduction following psilocybin treatment for anxiety and depression in patients with life-threatening cancer: a randomized controlled trial. *J. Psychopharmacol.* **30**, 1165–1180 (2016). <https://doi.org/10.1177/0269881116675512>
33. Chisholm, D., Sweeny, K., Sheehan, P., et al.: Scaling-up treatment of depression and anxiety: a global return on investment analysis. *Lancet Psychiatry* **3**, 415–424 (2016). [https://doi.org/10.1016/S2215-0366\(16\)30024-4](https://doi.org/10.1016/S2215-0366(16)30024-4)
34. Santini, Z.I., Jose, P.E., York Cornwell, E., et al.: Social disconnectedness, perceived isolation, and symptoms of depression and anxiety among older Americans (NSHAP): a longitudinal mediation analysis. *Lancet Public Health* **5**, e62–e70 (2020). [https://doi.org/10.1016/S2468-2667\(19\)30230-0](https://doi.org/10.1016/S2468-2667(19)30230-0)
35. Liu, C.H., Zhang, E., Wong, G.T.F., et al.: Factors associated with depression, anxiety, and PTSD symptomatology during the COVID-19 pandemic: Clinical implications for U.S. young adult mental health. *Psychiatry Res.* **290** (2020). <https://doi.org/10.1016/j.psychres.2020.113172>
36. Katon, W., Russo, J., Gavin, A.: Predictors of postpartum depression. *J. Womens Health* **23**, 753–759 (2014). <https://doi.org/10.1089/jwh.2014.4824>

37. Vliegen, N., Casalin, S., Luyten, P.: The course of postpartum depression: a review of longitudinal studies. *Harv. Rev. Psychiatry* **22**, 1–22 (2014)
38. Croxford, A., Notley, C.J., Maskrey, V., et al.: An exploratory qualitative study seeking participant views evaluating group Cognitive Behavioral Therapy preparation for alcohol detoxification. *J. Subst. Use* **20**, 61–68 (2015). <https://doi.org/10.3109/14659891.2014.894590>
39. Kalemenev, S.V., Zubareva, O.E., Frolova, E.V., et al.: Impairment of exploratory behavior and spatial memory in adolescent rats in lithium-pilocarpine model of temporal lobe epilepsy. *Dokl. Biol. Sci.* **463**, 175–177 (2015). <https://doi.org/10.1134/S0012496615040055>