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Trends in machine learning for predicting personality disorder: a bibliometric analysis

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ABSTRACT

Over the last decade, research on artificial intelligence (AI) in the medical field has increased. However, unlike other disciplines, AI in personality disorders is still in the minority. For this reason, we conduct a map research using bibliometric and build a visualization map using VOSviewer in AI to predict personality disorders. We conducted a literature review using the systematic literature review (SLR) method, consisting of three stages: planning, implementation, and reporting. The evaluation involved 22 scientific articles on AI in predicting personality disorders indexed by Scopus Quartile Q1–Q4 from the Google Scholar database during the last five years, from 2018–2023. In the meantime, the results of bibliometric analysis have led to the discovery of information about the most productive publishers, the evolution of scientific articles, and the quantity of citations. In addition, VOSviewer's visualization of the most frequently occurring terms in abstracts and titles has made it easier for researchers to find novel and infrequently studied subjects in AI on personality disorders.

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1. INTRODUCTION

Personality greatly influences a person in interacting with his social environment. In the social environment, cases of personality disorder are often found in a person [1]. Stress is the root cause of personality disorders [2]. According to WHO data in 2019, 1 out of every 8 people, or around 970 million worldwide, live with mental disorders [3]. This is not comparable to Indonesia, where there are only about 2,717 clinics, according to data currently available from the association of clinical psychologists as knows as *ikatan psikologis klinis* (IPK) [4]. Furthermore, verbal reports from patients and protracted interviews with psychiatrists, are the mainstays of traditional methods used to diagnose patients with mental disorders. The outcomes of these methods can be subjective, expensive, and time-consuming [5]. Diagnosis of a personality disorder requires careful assessment by mental health professionals, and this process can be time-consuming and carries a certain degree of subjectivity. Therefore, implementing artificial intelligence (AI) in diagnosing personality disorders has become an interesting research topic.

AI provides techniques and algorithms that can be used to analyze and process data automatically [6]. AI use in personality disorder prediction can increase diagnostic precision, shed light on the variables that contribute to personality disorders, and offer a customized method of treating and managing patients. AI-based applications for mental health research and diagnosis have grown significantly in the last several years

[7]–[9]. For example, Jan *et al.* [10] proposed an AI depression monitoring system that uses vocal and visual cues to predict beck depression inventory-II (BDI-II) scores. Furthermore, Wen *et al.* [11] extracted multi-type grey-white matter features based on multimodal neuroimaging, then used a multicore learning classifier to assign weights to the kernel functions of each feature. Wantoro *et al.* [12] also developed a fuzzy model and profile matching to offer medication recommendations to individuals with type 2 diabetes. There has been a significant increase in research using machine learning (ML) to predict personality disorders in the last decade. Popular algorithms such as support vector machines (SVMs), random forest (RF), and deep learning (DL) are the main methods, demonstrating ML's ability to handle complex and multidimensional data. The cross-disciplinary collaboration between mental health scientists and data science experts is highly visible, with leading research centers in developed countries such as the United States and the United Kingdom leading the way. The main focus of the research is on disorders such as borderline, narcissistic, and antisocial, which have behavioral manifestations that are easier to measure using ML. In conclusion, this trend shows great potential in developing more accurate and data-driven predictive diagnostic tools.

Numerous scholarly articles have carried out comprehensive reviews of the literature regarding the use of AI in the medical field to treat cases of personality disorders [13], [14]. As far as we are aware, no thorough analysis of the literature on the use of ML to treat personality disorders has been carried out. This is based on VOSviewer-based bibliometric analysis and visualization. To quantify outcomes and track the advancement of science and technology via a more focused scientific literature process, bibliometric analysis must be done [15]. Quantitative document analysis, or bibliometrics, is used to analyze scientific publications, obtain a broad overview of research areas, collaborate or co-author with other researchers [16], [17], and evaluate research. Bibliometric analysis can support decision-making in research management. Citations are a common way that bibliometric analysis provides data on the quantity and caliber of articles. Keyword co-occurrence relationships [18], [19], the number of scientific articles [15], the number of citations [17], researchers or authors [20], and journal titles [21] are among the most often used data and study types in bibliometric analysis. Furthermore, this information usually does not give exact measurements but only estimates. As a result, decision-making still requires the expert opinion of researchers and cannot be based solely on bibliometric data [16].

In the meantime, researchers can more easily develop cutting-edge and discover novel research topics that are rarely discussed thanks to visualization using VOSviewer [22]. The application of network analysis and visualization facilitates understanding interdependencies and connections when using AI to predict personality disorders [23]. The objective of this paper is to conduct systematic literature reviews (SLR), bibliometric analyses, and visualizations using VOSviewer on 22 indexed scientific articles that were retrieved from the Google Scholar database and classified as Scopus Quartile Q1–Q4. The assessment comprises citation analysis, keyword analysis, journal titles, and the quantity of scientific articles. VOSviewer is a free tool available to the research community that can be used to create and view bibliometric maps and author-presented keyword maps based on co-occurrence [24]. In addition, VOSviewer can also be used to provide suggestions for the results of data analysis [25]. One of the unexpected results of this analysis was an imbalance in the focus of the study. For example, more common personality disorders such as borderline and antisocial disorders receive more attention, while other, rarer or complex personality disorders, such as schizotypal or avoidant personality disorder, are rarely analyzed. This may indicate bias in research or limitations in the availability of clinical data that can be analyzed using ML. These results indicate that there is still room for further exploration of under-studied perturbations in the context of ML-based predictions.

The main objective of this study is to analyze the trend of using ML in the prediction of personality disorders through a bibliometric approach. The study aims to identify the most commonly used ML algorithms, the countries and institutions leading the research in this area, as well as understand the clinical areas that are the most focused on research. Thus, this study seeks to provide an overview of the development and future direction of the use of ML in clinical psychology.

2. METHOD

This methodology provides a general framework for conducting a literature review on AI diagnosing personality disorders. In this paper, a literature review was performed using the SLR method. SLR seeks to compile all available research on a given subject, assess it critically, and draw conclusions from the analysis of the research findings [26]. SLR has been widely used in various research fields, including the field of health [27]–[31], AI [32]–[34], ML [35]–[38], agriculture [39], and finance/banking [40]. We are building the SLR in three stages: planning, implementation, and reporting. The SLR phases are displayed in Figure 1 and the detail steps taken are as:

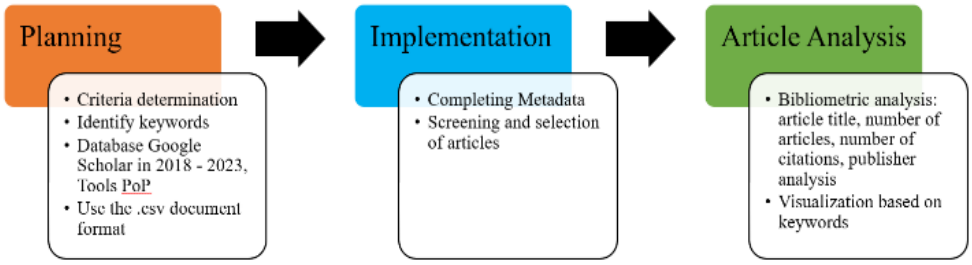

Figure 1. SLR stages

2.1. Planning

The first step is to identify SLR needs, such as determining research topic areas, objectives, and article selection criteria and identifying what keywords will be used in searching for research articles. The SLR of this study aims to investigate various AI methods used to diagnose personality disorders. In addition, the researcher also determined the criteria for the article in the literature review process, which can be seen in Table 1.

Table 1. Criteria for the article

No.	Inclusion	Exclusion
1.	English-language articles that have been published in the previous five years (2018–2023)	Published articles are theoretical discussions that are used as lecture material or tutorials
2.	The article discusses the application and methods of AI in personality disorder detection	Articles only contain an abstract or specific section
3.	The electronic database used is Google Scholar	
4.	Articles Quartile Q1–Q4 indexed by Scopus	

The keywords used must be relevant to the SLR topic for the literature search. Articles are collected using Harzing's publish or perish (PoP) using the keywords: "artificial intelligence", "personality disorder", and "machine learning". Because it offers a variety of article database options, including Crossref, Google Scholar, PubMed, Microsoft Academic, Scopus, and Web of Science, the PoP application was selected. However, this study only uses the Google Scholar database in the article search process. The most widely used source of scientific information is Google Scholar, a freely accessible database that covers most scientific research fields and is available to both the public and researchers [41]. In the initial search process, based on the keywords and criteria used in this study, 1,022 articles were found.

2.2. Implementation

The next step is to complete the metadata through Mendeley and continue with article screening. Articles that are irrelevant or do not meet the research criteria will be removed from the literature list. Table 2 shows the screening results. This paper will use 22 Scopus Quartile Q1–Q4 indexed articles based on the screening results.

Table 2. Article screening results

Criteria	The quantity of articles
Unrelated to the keywords	834
Not in English	14
Duplicate data	37
Not indexed by Scopus	115
Indexed Scopus quartile Q3, Q4	8
Indexed Scopus quartile Q1, Q2	14
Total	1,022

2.3. Article analysis

The final stage of the SLR is conducting a bibliometric analysis using VOSviewer version 1.6.19 and conducting an SLR analysis of 22 articles indexed by Scopus Quartile Q1–Q4. Articles indexed by Scopus Quartile Q1–Q4 significantly impact research citations [42] compared to non-indexed pieces, which can be used for citation analysis [41] and are commonly used in bibliometric analysis [43].

For the bibliometric analysis, the number of articles, journal titles, citation analysis, and keyword co-occurrence analysis are necessary.

3. RESULTS AND DISCUSSION

Scientific articles published by sixteen publishers are indexed by Scopus Quartile Q1–Q4. From the sixteen publishers, five publishers have published scientific papers on AI and personality disorders as seen in Figure 2. During the last five years, from 2018–2023, publisher Springer New York LLC published three articles (13.64%). Publisher SAGE Publications Inc., Frontiers Media S.A, Hindawi Limited, Springer Science and Business Media Deutschland GmbH published two articles each (9.09%). Meanwhile, publishers that have published only one paper (4.54%) in the last five years include MDPI, Springer, Elsevier Ltd, Inderscience Publishers, John Wiley and Sons Inc., JMIR Publications Inc., Elsevier B.V., S. Karger AG, Lippincott Williams and Wilkins, Academic Press Inc. and Springer Verlag. Thus, it can be said that, over the course of the last five years, each publisher produced, on average, one article, as indexed by Scopus Quartile Q1–Q4. The journal that produces the most articles is Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics) and IFIP Advances in Information and Communication Technology with Quartile Q3, which produces two articles each.

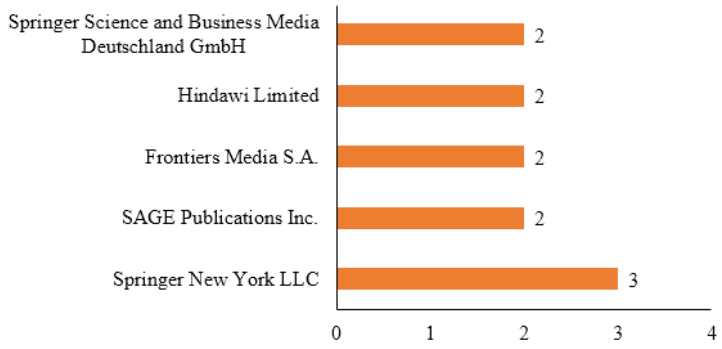

Figure 2. Top 5 publishers with the most scientific articles

3.1. Citation analysis

The article “Differential Effects Of Childhood Neglect And Abuse During Sensitive Exposure Periods On Male And Female Hippocampus” by [42] is one of the top 10 most cited articles published in the last five years by Academic Press Inc. with a total of 86 citations. The second rank is an article by [43] entitled “Behavioral Modeling for Mental Health using Machine Learning Algorithms” with 75 citations. The third rank is an article by [44] entitled “Machine Learning And Natural Language Processing In Mental Health: Systematic Review”, with 61 citations. In this top 10 citation analysis, publisher Academic Press Inc. contributed the most citations, with 86 citations can be seen in Table 3.

3.2. Keyword analysis

Using VOSviewer version 1.6.19, visualizations of 22 articles on AI for personality disorders indexed by Scopus Quartile Q1–Q4 were created to conduct keyword analysis. In the visualization process, the author uses all keywords, which contain 667 keywords. From this process, 138 keywords were found, which were divided into seven clusters. The results of the visualization can be seen in Figure 3.

ML is the most prevalent research topic in Cluster 1 (highlighted in red), which is made up of 27 research topics. The classification topic is the most prevalent in cluster 2 (green) with 26 research topics. In cluster 3 (navy blue), there are 25 research topics with the most dominant topic being AI which is the most discussed issue [47]–[49]. The cluster can be seen from the node size which is the largest among other nodes and has the most network connections. It can be concluded that the larger the node/node, the more popular it is, the more it has many network connections and is discussed more frequently [50]–[52]. In cluster 4 (yellow), there are 17 research topics, with the most dominant female topic. In cluster 5 (purple) and cluster 6 (light blue), there are 15 research topics, with the most prevalent issues, namely personality disorder and humans, respectively. In cluster 7 (orange), there are 13 research topics, with the most dominant being male.

Based on visualization with VOSviewer, several research topics are rarely discussed, including natural language processing (NLP) systems for personality disorders, decision support systems, data mining,

DL, text mining, and feature selection. Figure 4 shows a visualization of keyword density in the AI field. Figure 4 shows the level of density or density of research topics. The yellow indicates that the topic is the topic with the highest density, while the blue represents the lowest density level [53]. That means that topics with the lowest density are new topics that are rarely discussed. 2020 saw discussions on this new research topic, as shown by the yellow line in Figure 5. Overall, the keyword AI is the most frequently found in the title and research abstract of the 138 keywords obtained, followed by the word's human, humans, article, personality disorder and so on. The keywords often found (top 10 keywords) can be seen in Table 4.

Table 3. Article screening results

Rank	Citation	Authors	Title	Journal	Quartile	Year	Publisher
#1	86	Teicher M.H.; Anderson C.M.; Ohashi K.; Khan A.; McGreenery C.E.; Bolger E.A.; Rohan M.L.; Vitaliano G.D.	Differential effects of childhood neglect and abuse during sensitive exposure periods on male and female hippocampus [42]	NeuroImage	Q1	2018	Academic Press Inc.
#2	75	Srividya M.; Mohanavalli S.; Bhalaji N.	Behavioral modeling for mental health using machine learning algorithms [43]	Journal of Medical Systems	Q1	2018	Springer New York LLC
#3	61	Le Glaz A.; Haralambous Y.; Kim-Dufor D.-H.; Lenca P.; Billot R.; Ryan T.C.; Marsh J.; DeVylder J.; Walter M.; Berrouiguet S.; Lemey C.	Machine learning and natural language processing in mental health: systematic review [44]	Journal of Medical Internet Research	Q1	2021	JMIR Publications Inc.
#4	20	Sadeghi D.; Shoeibi A.; Ghassemi N.; Moridian P.; Khadem A.; Alizadehsani R.; Teshnehlab M.; Gorriz J.M.; Khozeimeh F.; Zhang Y.-D.; Nahavandi S.; Acharya U.R.	An overview of artificial intelligence techniques for diagnosis of Schizophrenia based on magnetic resonance imaging modalities: methods; challenges; and future works [45]	Computers in Biology and Medicine	Q1	2022	Elsevier Ltd
#5	16	Squarcina L.; Villa F.M.; Nobile M.; Grisan E.; Brambilla P.	Deep learning for the prediction of treatment response in depression [46]	Journal of Affective Disorders	Q1	2021	Elsevier B.V.
#6	11	Frías Á.; Palma C.; Salvador A.; Aluco E.; Navarro S.; Farriols N.; Aliaga F.; Solves L.; Antón M.	B·RIGHT: usability and satisfaction with a mobile app for self-managing emotional crises in patients with borderline personality disorder [47]	Australasian Psychiatry	Q2	2021	SAGE Publications Inc.
#7	10	Friás Á.; Solves L.; Navarro S.; Palma C.; Farriols N.; Aliaga F.; Hernández M.; Antón M.; Riera A.	Technology-based psychosocial interventions for people with borderline personality disorder: a scoping review of the literature [48]	Psychopathology	Q1	2020	S. Karger AG
#8	8	Salem H.; Ruiz A.; Hernandez S.; Wahid K.; Cao F.; Karnes B.; Beasley S.; Sanches M.; Ashtari E.; Pigott T.	Borderline personality features in inpatients with bipolar disorder: impact on course and machine learning model use to predict rapid readmission [49]	Journal of Psychiatric Practice	Q3	2019	Lippincott Williams and Wilkins
#9	4	Kamran Ul Haq A.; Khattak A.; Jamil N.; Naeem M.A.; Mirza F.	Data analytics in mental healthcare [50]	Scientific Programming	Q3	2020	Hindawi Limited
#10	3	Ellouze M.; Mechti S.; Belguith L.H.	Approach based on ontology and machine learning for identifying causes affecting personality disorder disease on Twitter [51]	Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)	Q3	2021	Springer Science and Business Media Deutschland GmbH

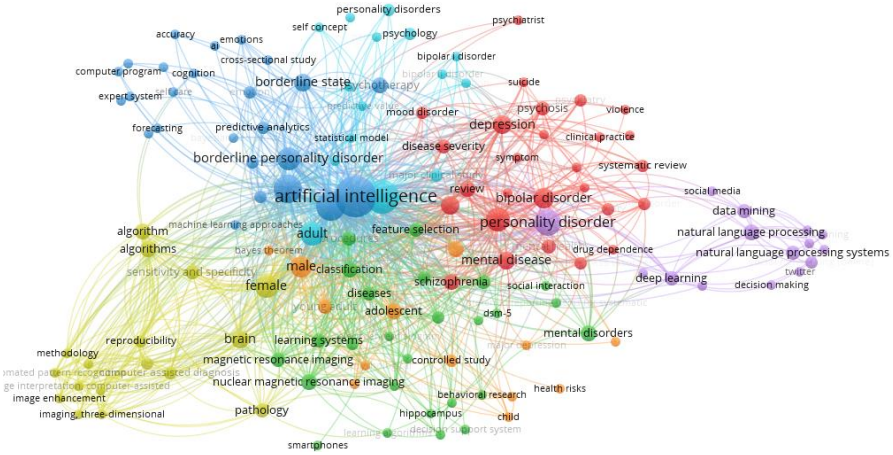

Figure 3. Keyword co-occurrence in AI research for personality disorders

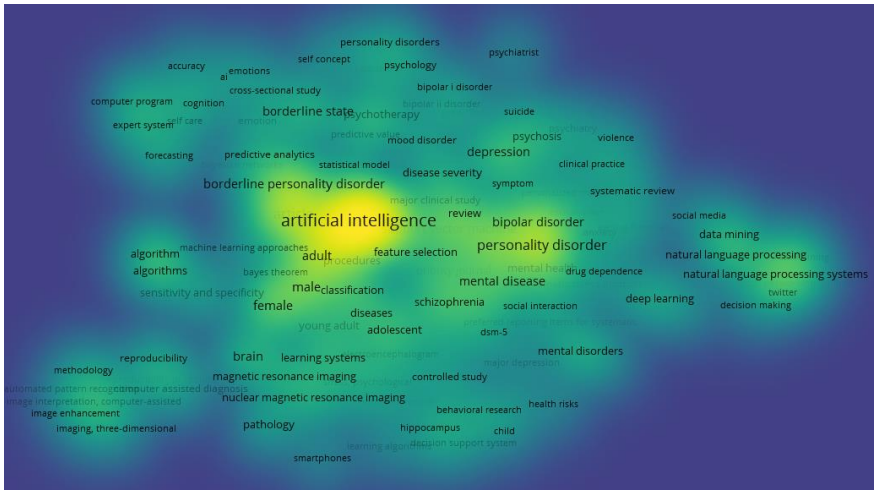

Figure 4. Visualization of keyword density in the field of AI

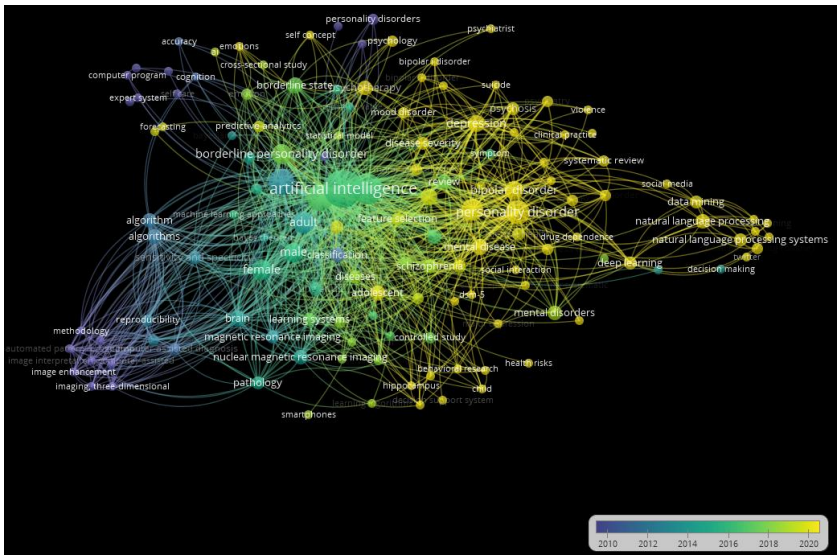

Figure 5. An illustration of the top keywords in the field of AI

Table 4. Keyword found in title and abstract

Keyword	Occurences
Artificial intelligence	33
Human	22
Humans	17
Article	16
Personality disorder	14
Adult	11
Machine learning	11
Female	10
Borderline personality disorder	10
Male	9

4. CONCLUSION

In this article, we conducted a bibliometric analysis and visualization analysis using VOSviewer in the fields of AI and personality disorders. We used 22 scientific articles indexed in Scopus quartile Q1–Q4 from the Google Scholar database for the last five years (from 2018–2023). The bibliometric analysis's findings reveal that sixteen publishers release scholarly works that are indexed by Scopus Quartile Q1–Q4. Springer New York LLC publishers produce the most scholarly articles, and Academic Press Inc. publishers have the most citations during 2018–2023, with 86 citations. At the exact time visualization was carried out using VOSviewer, it was found that the keyword "artificial intelligence" often appeared in titles and abstracts, compared to other terms. Additionally, visualization revealed some previously unexplored research areas, such as text mining, DL, NLP systems, decision support systems, data mining, and feature selection for personality disorder prediction. Research on the topic of data mining is a research topic that has yet to be discussed and will only appear to be researched in 2020.

Because the Google Scholar database is being used to search for scientific articles, this research needs to be more narrowly focused. It takes research with robust databases such as Scopus, Web of Science, and PubMed to retrieve more specialized and high-caliber scientific articles from reliable journals. The findings of this study make a significant contribution to the field of research and communities focused on mental health and AI. In the context of personality disorder prediction, this study highlights how ML is increasingly being adopted as an effective tool to improve diagnostic accuracy and predict psychological conditions.

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