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The Role of AI-Driven Tools for Early Detection of Mental Health Disorders: A Systematic Review

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Abstract

The objective of this study was to systematically review the use of AI and related tools in the detection of mental health disorders. A systematic literature review was carried out on the studies searched and gathered from 1st June 2024 to 30th August 2024. The sample included 12 research papers addressing a vast array of AI applications and neurological conditions; furthermore, SPSS and Excel software were used for performing statistical analysis and producing relevant graphs on the aforementioned chosen studies. The study included mental disorders in broad terms (18.9%), Depression (13.5%), Anxiety (10.8%), Schizophrenia (8.1%), autism spectrum disorder (8.1%), Epilepsy (5.4%), Bipolar (5.4%), PTSD (2.7%), Intellectual Disability (2.7%), Identity Disorder (2.7%), Suicide (2,7%), Self-Harm (2.7%), ADHD (2.7%), Dyslexia (2.7%), Tourette's Syndrome (2.7%), Obsessive Compulsive disorder (2.7%), Mental Disorders of visual field (2.7%), and Substance Abuse Disorder (2.7%). About 66.6% of the studies containing information about their AI application's efficacy rated it moderate or higher than 50% with a further 22.2% of studies containing mixed results, overall suggesting a high positive correlation between the use of AI in detecting mental health disorders with appropriate human oversight required in addressing said conditions.

Keywords: artificial intelligence, psychopathology, meta-analysis, mental health

Introduction

Mental health and psychiatric illnesses have been increasingly cited as an upward spiral in the post-COVID era as several people have experienced numerous extraordinary situations (Costa et al., 2022). With the current clinical workforce deemed insufficient to deal with this acceleration in multiple parts of the world and an increasingly crisis-ridden society monetary-wise, it has become increasingly important to look into alternatives; a viable solution being technology itself. Simultaneously, a new phenomenon encompassing algorithms that emulate human cognitive functions of reasoning, learning, and problem-solving has emerged – Artificial Intelligence or AI (Yin et al., 2021). The conditions mentioned above that most of the world has found itself in, have prompted many to gaze into this new aspect of technology to not only accommodate people but also help mental health professionals by creating innovative tools to ease their increasingly stressful jobs (Tutun et al., 2022).

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Several different applications of AI, such as machine learning and deep learning are now being utilized in a multitude of ways to help out the common man and psychologists/psychiatrists alike. Some of the most notable ones in use by the common man include a plethora of chatbots, such as character.ai and Alexa by Amazon, while psychologists and psychiatrists are now known to include digital brain biomarkers, physiological signals, and a plethora of other applications by corroborating with AI (Rosso, 2022). These applications themselves stem from several samples of human-computer interactive technology in use from the inception of AI in the 1950s. A particular emphasis should be placed on these historical precursors of modern-day AI applications as they provide a unique insight into the way psychologists and the general public tend to approach the topic at hand. Some of these past inventions include ELIZA, a 1964-MIT-designed natural language processing program. ELIZA's defining weakness was its inability to fully understand a conversation's information though this weakness was complemented by it showing some level of emotional attachment. A later 1972 Stanford-designed PARRY program, which was a live replica of a schizophrenic person, was counseled several times by ELIZA in one of the first such examples of AI involvement in detecting mental health disorders (Vaidyam et al, 2019).

This technology is now emulated by both the general public & professionals within the field of mental health professionals alike with a variety of potential applications still surfacing across numerous interdisciplinary crossroads of Computer Science & Psychology. With various organizations labeling this road as "the future of therapy" (Vaidyam et al, 2019), it has become an intangible part of therapy and the diagnosis of neurological disorders. Increasingly, numerous people around the world are also pursuing the aforementioned subjects in a variety of different ways, which include education and certain skills, producing an array of innovations, which have since become necessary to be thoroughly studied through an academic lens. According to the knowledge available to the researchers, this is among the first literature reviews thoroughly examining a variety of pinpointed mental and neurological disorders and a multitude of AI applications. Most of the research has been especially centered on chatbots (Abd-Alrazaq et al., 2019; Boucher et al., 2021; Deshpande & Warren, 2021; Vaidyam et al, 2019) and depression (including the researchers talking about depression) as a common mental health condition through AI applications. It would be common sense to assume that the intersection of Computer Science and Psychology transcends far beyond the aforementioned minute aspects of both subjects. Regardless, a wide variety of research encompassing a multitude of different AI applications as well as different mental health conditions is not readily available which has aimed to bridge this research paper.

The researchers included a plethora of studies concerning the use of deep learning, digital biological datasets, bot list directories, and a variety of different applications numbering up to 17. Similarly, the researchers also included a wide variety of research available to them on several mental health conditions, neurodevelopmental disorders, and simple research concerning self-harm and suicide amongst the general population. They noted at least one viewpoint of an application deemed important was noted and researched and were able to find appropriate research, while also encompassing the same mindset when scouring for different research on mental health

and neurodevelopmental disorders. By doing so, they have tried to summarize the empirical evidence of the positives and negatives associated with the implementation of AI in psychological and psychiatric circles and provided suggestions for any future research in this subject area.

The researchers' objective was to review and synthesize current literature on AI-driven tools for early detection of mental health disorders with their focus being on studies published in the last five years (2019–2024). They aimed to answer the following questions: What AI-driven tools are currently being used or developed for early detection of mental health disorders? What methodologies are employed in these tools (e.g., machine learning algorithms, natural language processing)? How effective are these tools in early detection compared to traditional methods? What are the challenges and ethical considerations associated with these AI tools? They searched relevant databases such as Google Scholar. They screened the titles appropriately, and their eligibility criteria are expanded upon in the next section. The researchers then identified recurring themes and patterns in the studies, such as common AI techniques or challenges faced. They then give an overview of the importance of early detection of mental health disorders and the role of AI, provide a detailed description of the literature search strategy along with the inclusion/exclusion criteria and data extraction process, summarize the findings, including common AI techniques, effectiveness, challenges, and ethical considerations, interpret the findings, discuss their implications for practice and research, and suggest future research directions, and finally summarize the key insights gained from the literature review.

Method

Search Strategies

This systematic review was conducted by guidelines as set by PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis). The researchers employed Google Scholar and Research Gate as their primary sources for identifying relevant articles for the study, which they did in June 2024. The search was limited to articles written in English in peer-reviewed journal articles published between January 2019 to June 2024. This time frame was set by innovations in technology that had recently emerged and the growing trend of AI & the importance of Psychology in the era during and after the COVID-19 virus. Two groups of keywords were used to identify appropriate titles, abstracts, and publications. The researchers' first group of keywords included terms related to Artificial Intelligence; it must be noted that Artificial Intelligence in itself is a huge term and phenomenon that includes numerous things, however, studies employing these techniques in their topic area were likely to use specific keywords with a few examples being "algorithms," "deep learning," and "Chabot" in addition to specific keywords as required. Similarly, they understood the vastness of the term "mental health disorders" too so the researchers included common keywords such as "depression" and "neurological disorders" in addition to specific keywords.

Eligibility Criteria

Once the studies were downloaded after an initial shortlist by using Google Scholar and Research Gate, the researchers removed any duplicate studies present in their sample. Three researchers (SAC, MS, MA) screened the titles and abstracts from the shortlist at that period to

determine the quality and suitability of the study. The consensus was maintained among all researchers and no disagreements occurred during the process. The inclusion criteria depended on (1) the study discussing an appropriate Artificial Intelligence application to detect a specified mental health or neurological disorder and (2) the study contained a viable correlation between said applications' results and the disorder they diagnosed. A specific population was not targeted as the researchers' prime aim was to focus on the impact of Artificial Intelligence in psychopathology on the general populace. Specific Artificial Intelligence techniques and mental health disorders included are listed in Table 1. The exclusion criteria were based on (1) the study did not specify which Artificial Intelligence technique was being used to diagnose a mental health disorder and (2) the study failed to identify the mental health disorder, even in broad terms, that their Artificial Intelligence application diagnosed. The researchers also excluded conference abstracts, commentaries, simulation papers, and ongoing studies from the sample.

Figure 1

Data Extraction and Charting

After selecting relevant articles for the study, the researchers proceeded forward with creating a data-charting form to extract suitable information from every article as relevant to or required by that particular study. They included the following aspects: study characteristics, Artificial Intelligence applications, mental health conditions covered, and the stated efficacy in the research papers. Study Characteristics

- Author & publication
- Year of publishing
- Study design
- Relevant information stated in the abstract

Artificial Intelligence Applications

- AI method used
- Description of the method used
- Evaluation of correlation between an already existing method now used along with AI

Mental Health Disorders

- Mental Health conditions and neurological disorders
- Description of stated conditions and disorders
- Evaluation of the research paper's incorporation of several mental health disorders or not

Efficacy

- Description of accuracy as a percentage or stated in words if stated
- Highlighted into three categories based on accuracy

Results

The researchers' initial vetting yielded a plethora of studies on the topic, numbering over 50 and spread across a variety of different Artificial Intelligence methods & mental health

conditions; an example being Pham et al, 2022. First removing any duplicates from the list, they identified and isolated several studies based on titles and abstracts. This brought the list of articles down to 20. The researchers further excluded more studies by screening the stated academic studies and their relevance to the study once again. At the same time, the researchers included about 3 studies in their list based on their academic relevance to them as well as their assessment of key Artificial Intelligence applications and some mental health conditions.

Table 1

Characteristics of Reviewed Papers

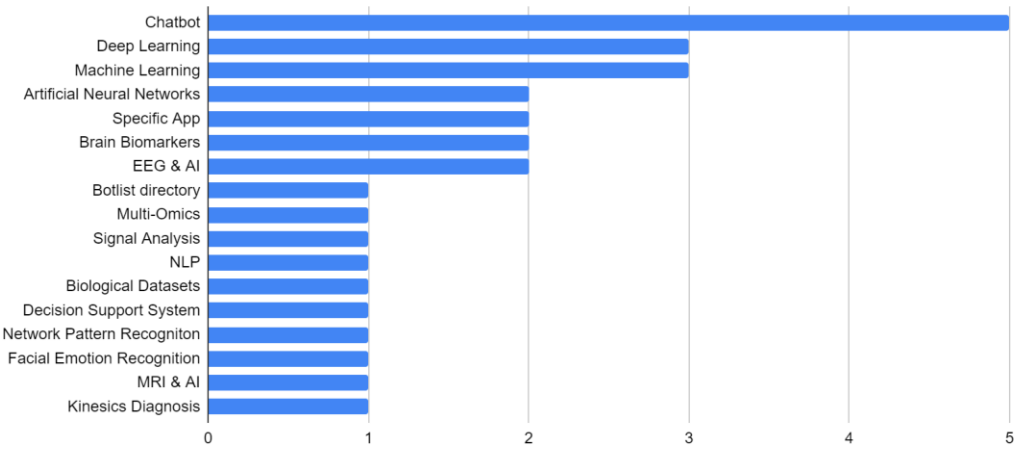
Author, Year	Study Design	AI Applications	Mental Health Conditions
Vaidyam et al. (2019)	Systematic Literature Search	Chatbot	Depression, Anxiety, Schizophrenia, Bipolar, Substance Abuse Disorder
Deshpande & Warren (2021)	Sentimental Analysis	Chatbot, NLP	Suicide, Self-Harm
Uddin et al. (2019)	Review Article	Biological Datasets	Neurodevelopmental Disorders, Identity Disorder, Autism Spectrum Disorder, Epilepsy
Tutun et al. (2022)	Experimental Research Design	DSS, Machine Learning, NEPAR	Depression, Bipolar, Schizophrenia, Anxiety
Rivera et al. (2021)	Systematic Mapping Study	EEG, Brain Biomarkers, DL, Machine Learning	Epilepsy predominant disorder
Jungmann et al. (2019)	Pilot Study	Specific App, Chatbot	A broad spectrum of mental disorders
Lin et al. (2020)	Review Article	DL, Neural networks, multi-omics, brain biomarkers	Psychiatric Disorders
Abd-Alrazaq et al. (2019)	Scoping Review	Chatbots	Depression, Autism Spectrum Disorder, and Other Mental Disorders
Aina et al. (2024)	Experimental Research Design	Facial Emotion Recognition, Neural Networks	Depression, Anxiety, and Mental Disorders based on visual cues
Liu et al. (2020)	Systematic Review Article	MRI, EEG, kinesics diagnosis	Psychiatric Disorders
Khare et al. (2023)	Systematic Review Article	Signal Analysis, Machine learning, DL	Autism Spectrum Disorder, Attention Deficit Hyperactivity Disorder, Schizophrenia, Anxiety, Depression, Dyslexia, PTSD, Tourette's Syndrome, Obsessive Compulsive Disorder
Boucher et al. (2021)	Review Article	Chatbots, Botilist Directory, Specific App	Mental Health Conditions

Artificial Intelligence Characteristics

Among the 12 studies included in this systematic review, a total of 14 Artificial Intelligence techniques and applications were used. The most widespread applications were that of Chabot's (*n*=5). These were followed by Deep Learning (*n*=3), Machine Learning (*n*=3), Artificial Neural Networks (*n*=2), a specific app (*n*=3), Brain Biomarkers (*n*=2), Signal Analysis (*n*=2), Electroencephalography & Artificial Intelligence (*n*=2), Botlist Directory (*n*=1), Multi-Omics (*n*=1), Computer-Aided Design System (*n*=1), Natural Language Processing (*n*=1), biological datasets (*n*=1), Decision Support System (*n*=1), Network Pattern Recognition (*n*=1), Facial Emotion Recognition (*n*=1), Magnetic Resonance Imaging & Artificial Intelligence (*n*=1), and Kinesics Diagnosis (*n*=1). This is shown in Figure 2.

Figure 2

Artificial Intelligence Methods Used for Detection of Mental Health Disorders



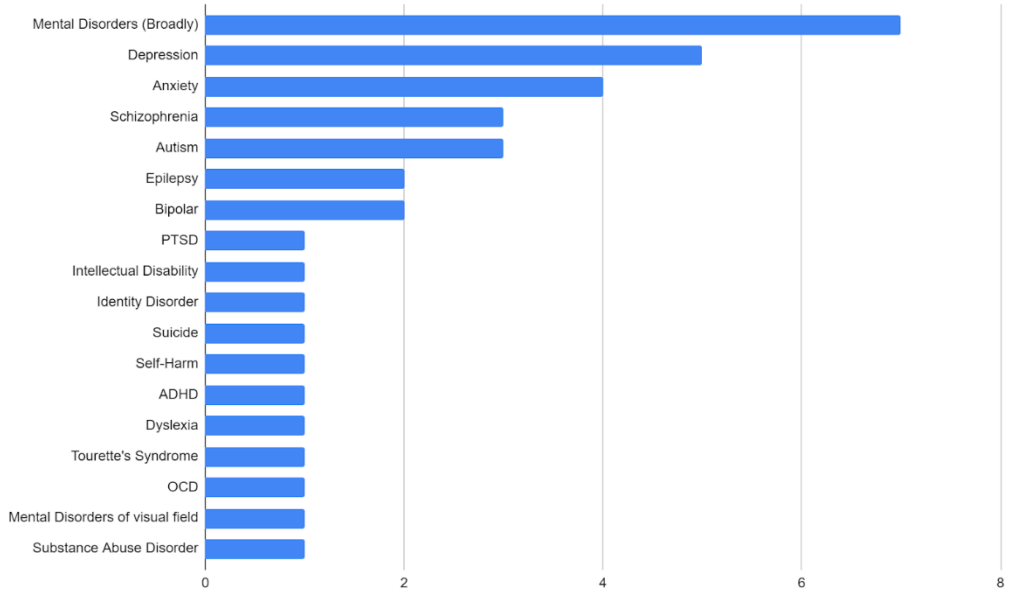
Note. NLP = Natural Language Processing, MRI = Magnetic Resonance Imaging, EEG = Electroencephalography

Mental Conditions Characteristics

The most prevalent mental health condition was mental disorder in general terms (*n*=7) with depression (*n*=5) in second place. These were followed by anxiety (*n*=4). Schizophrenia (*n*=3), Autism Spectrum Disorder (*n*=3), Epilepsy (*n*=2), Bipolar (*n*=2), PTSD (*n*=1), Intellectual Disability (*n*=1), Identity Disorder (*n*=1), Suicide (*n*=1), Self-Harm (*n*=1), ADHD (*n*=1), Dyslexia (*n*=1), Tourette's Syndrome (*n*=1), Obsessive Compulsive Disorder (*n*=1), Mental Disorders of visual field (*n*=1), and Substance Abuse Disorder (*n*=1). This is shown in Figure 3.

Figure 3

AI Detected Mental Health Disorders

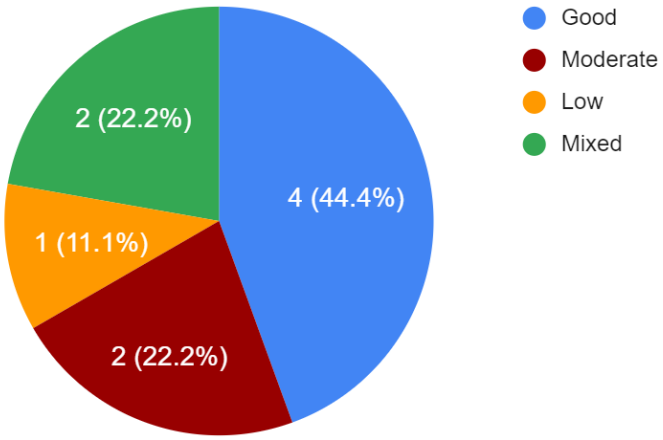


Note. Mental Disorders (Broadly) = Term "Mental Disorders" and related terms mentioned in broad terms, PTSD = Post Traumatic Stress Disorder, ADHD = Attention deficit hyperactivity disorder, OCD = obsessive compulsive disorder

The researchers ranked the evaluation outcomes in their review studies based on one finding stated in a majority of all mentioned studies – efficacy. Figure 4 gives an overview of the researchers' characterization of efficacy: Good (stated or >80%), Moderate (stated or >45% AND <85%), Low (stated or <45%), and Mixed (study had reservations when subscribing to either of their three other characterizations).

Figure 4

AI Tool's Efficacy in the Detection of Mental Health Disorders



Nine of the studies (Abd-Alrazaq et al., 2019; Aina et al., 2024; Deshpande & Warren, 2021; Jungmann et al., 2019; Khare et al., 2023; Lin et al., 2020; Rivera et al., 2021; Tutun et al., 2022; Vaidyam et al, 2019) explicitly mentioned the efficacy and future eligibility of using Artificial Intelligence in detecting mental health conditions with four studies (Boucher et al., 2021; Liu et al., 2020; Uddin et al., 2019; Rivera et al., 2021) either did not state anything related to efficacy in their study or were not clear on it.

Four of the studies had a potency rated as Good. The highest of this was found in the study concerning suicide and self-harm where a chatbot was combined with an LSTM-RNN classifier using BERT-Encoding to have an accuracy of 92.13% with the accuracy rising even higher to 97% on testing with data from Reddit and Twitter (Deshpande & Warren, 2021). Another study (Tutun et al., 2022) utilized Network Pattern Recognition Algorithms with machine learning and a Dynamic Support System to detect an array of mental health disorders such as depression, bipolar, schizophrenia, and anxiety to an accuracy level of 89% after asking 28 questions. An additional study utilized Facial Emotion Recognition with Convolutional Neural Networks to detect an array of mental disorders including depression, anxiety, and disorders based on visual cues to an accuracy rate of 81% using a proposed ensemble technique (Aina et al., 2024). A fourth study (Vaidyam et al, 2019) used chatbots and a systematic literature search on populations at high risk of developing depression, anxiety, schizophrenia, bipolar, and substance abuse disorders to high satisfaction.

Two of the studies had Moderate efficacy. One study, utilizing a combination of deep learning, neural networks, multi-omics, and digital brain biomarkers with neuroimaging data to diagnose psychiatric disorders, had more than at least 68.1% accuracy (Lin et al., 2020). The other (Rivera et al., 2021) used EEG, Brain Biomarkers, DL, and Machine Learning to diagnose epilepsy as the predominant disorder.

Only one study, using a combination of a botanist directory and a chatbot to diagnose Autism Spectrum Disorder, Attention Deficit Hyper-Activity Disorder, schizophrenia, anxiety, depression, dyslexia, Post Traumatic Stress Disorder, and obsessive-compulsive disorder, rated Artificial Intelligence as unreliable for clinicians with developed models unable to illustrate diagnosis to clinicians (Khare et al., 2023).

Two studies had mixed results where one was unclear on the overall efficacy (Jungmann et al.,2019) and the other had reservations about Artificial Intelligence although it rated efficacy highly (Abd-Alrazaq et al., 2019). The first one used a specific app to diagnose a broad spectrum of mental disorders. The app showed a log diagnostic agreement between the results of the app and children, a moderate diagnostic agreement between results of the app and case vignettes in adulthood, a moderate diagnostic agreement between results of the app and case vignettes of students and layperson, and a good diagnostic agreement between results of the app and when given by psychotherapists (Jungmann et al., 2019). The other study used several chatbots chosen through set criteria to diagnose depression, autism, and mental disorders to have a good efficacy based on nascent research with, however, healthcare providers being there to guide the patient (Abd-Alrazaq et al., 2019).

Discussion

AI applications are currently having a huge impact on the way psychologists and psychiatrists are diagnosing certain mental health conditions with many techniques not only easing their job but also making their predictions and diagnosis more accurate. AI through the identification of relevant patterns in data concerning a patient, it can help diagnose a mental illness (Walsh et al., 2017) This review seeks to identify and summarize appropriate studies on AI applications and yielded the following findings. At face value, the researchers noted that the number of included studies is in a particularly minute quantity considering the amount of research now present at the crossroads of Computer Science and Psychology. They attribute this quantity to the focus of only a few Artificial Intelligence techniques, such as chatbots and natural language processing, to diagnose a small number of mental health conditions, the most prevalent being depression. In their quest to include as many varieties of Artificial Intelligence techniques and mental health conditions as possible, the researchers found it redundant to include a plethora of studies focused on the same topic area with similar results while negating other aspects of the topic.

Secondly, almost the entirety of the authors of the included studies were from developed countries with many studies particularly hailing from the United States of America and Europe (Aina et al., 2024; Boucher et al., 2021; Jungmann et al., 2019; Khare et al., 2023; Lin et al., 2020; Rivera et al., 2021; Tutun et al., 2022; Uddin et al., 2019), where the stigma around mental health is particularly low which explains this result. This is also consistent with the fact that several Artificial Intelligence powerhouses are present in the United States and Europe that may have more incentive to focus on the use of Artificial Intelligence in diagnosing mental health conditions. However, it is important to note that eight of the included studies had at least 1 author hailing from an Asian or a Middle-Eastern country (Abd-Alrazaq et al., 2019; Aina et al., 2024; Khare et al., 2023; Liu et al., 2020; Tutun et al., 2022; Uddin et al., 2019), noting that countries present in that part of the globe are also taking a particular interest in this topic. With several Arab countries investing in alternatives to expand their economy in the future, that part of the world is poised to have a significant effect in the interdisciplinary field of Computer Science and Psychology and into this topic.

Concerning the acceptance or a positive attitude toward the use of Artificial Intelligence techniques to diagnose mental health conditions, the researchers found a plethora of studies (Aina et al., 2024; Boucher et al., 202; Deshpande & Warren, 2021; Lin et al., 2020; Liu et al., 2020; Tutun et al., 2022; Uddin et al., 2019; Vaidyam et al, 2019) having positive feelings for the topic area with 1 study (Abd-Alrazaq et al., 2019) showcasing mixed feelings towards the topic. Interestingly, the remaining 3 studies (Khare et al., 2023; Jungmann et al., 2019; Rivera et al., 2021) looking at the topic through a negative lens had their primary author from mainland Europe, with only one of the studies (Khare et al., 2023) having an additional two authors from Australia and India. This finding may show regional biases towards the use of Artificial Intelligence in detecting mental health disorders.

As stated previously in evaluation outcomes. 44.4% of the studies stated that the efficacy of using Artificial Intelligence techniques in detecting mental health disorders was good while a further 22.2% stated that it was moderately good. This suggests cautious optimism being taken into account when evaluating any results for this topic area. While 66.6% of studies had a higher than 45% efficacy, the remaining third of studies should not be disregarded and taken into account. One can, therefore, assume that more research is required into certain conditions and techniques before industrializing them on a larger scale while some techniques, like chatbots, can be used to diagnose certain conditions, like depression and self-harm, due to the plethora of research yielding high efficacy.

Lastly, the researchers suggest the inclusion of those mental health conditions and Artificial Intelligence techniques that were present in a minute quantity in the studies used in this paper within future studies for more innovation within this topic to improve workplace efficiency in regards to the diagnosis of mental health conditions by psychologists and psychiatrists while also helping the wider public. Any person interested in doing so may find the "Artificial Intelligence Characteristics" and "Mental Conditions Characteristics" categories useful for this purpose.

Conclusion

Artificial Intelligence applications have huge potential to revolutionize the psychological and psychiatric world in an undaunting way. Based on the literature present in this review, there is a high positive correlation between using Artificial Intelligence to detect mental health disorders and the evaluated data. It must be noted though that further research at the crossroads of Psychology and Computer Science is required to contribute towards a safer and more comprehensive use of said technology for the topic. More research within Artificial Intelligence techniques having minute or no research in combination with mental health conditions having minuscule research will yield further benefits, trending the aforementioned correlation towards a more positive trend. When a large amount of research is available to increase the sample size of said techniques and disorders mentioned in this study, a comprehensive evaluation of all technology will help in moving closer to practice from theory.

Limitations

This review was the subject of several limitations which can be addressed by future research within this field. The researchers found their prime concern to be the inclusion of peer-reviewed English-written research within their study only. It is, however, reasonable that some relevant articles were published in a language other than English. Moreover, it is entirely plausible that other pieces of academic studies, such as essays and news articles, provide a better overview of said topic. In addition to the aforementioned limitations, it is also rational, to a smaller degree, however, that significant research was conducted at the crossroads of Psychology and Computer Science before 2019 that is valuable and appropriate for current implementation and their study.

Another concern the researchers faced was their lack of inclusion of Computer Science databases concerning their topic. This, too, should not be a big concern as these journals focus

primarily on the training and execution of new Artificial Intelligence applications without formal deployment. They were also well aware of the fact that certain AI applications may be in use but do not have formal or openly accessible publications for review. Future research, however, can expand the scope of research on this topic by providing a deeper insight into novel state-of-the-art Artificial Intelligence resources.

One last concern the researchers faced was the lack of inclusion of certain mental health conditions or Artificial Intelligence applications. For instance, they did not come across a viable study concerning dissocial disorders or any personality disorder regarding mental health disorders and were also unable to find an appropriate study concerning generative AI and data mining when gauging Artificial Intelligence applications. Many terms for Artificial Intelligence are subjective as some individuals may combine those terms while others may prefer to keep them separate, an example being machine learning and natural language processing. Moreover, their study's inclusion of certain mental health disorders and Artificial Intelligence techniques amounted to a minute number, for example, Tourette's and facial emotion recognition were present in only one study each. The used study could, therefore, be an outlier within the analysis of the same Artificial Intelligence technique or mental health disorder when compared to other studies. Future research, once again, can fill this gap by producing more relevant studies on mental health disorders and Artificial Intelligence techniques absent from or present in small quantities in this study.

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