
Impact of AI-Induced Cognitive Overload on Treatment Adherence in Patients with GAD: The Moderating Role of Digital Health Literacy

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Abstract

The fast adoption of artificial intelligence (AI) in the healthcare field has revolutionized the manner in which patients are educated about their health and how they manage their own health, but the problem of overload of information created by AI can also lead to cognitive load especially, among Generalized Anxiety Disorder patients. This research focused on assessing the effects of cognitive overload induced by AI on the adherence to treatment among GAD patients, as well as the role of digital health literacy as a moderator. Cross-sectional type of analysis was carried out on a sample of 120 diagnosed GAD patients aged between 18 and 60 years and recruited through a stratified random sampling method in psychiatric outpatient units and online mental health services. The structured questionnaire included the AI Cognitive Overload Scale (AICOS), Generalized Anxiety Disorder- 7 (GAD-7) scale, Treatment Adherence Questionnaire (TAQ), and Digital Health Literacy Instrument (DHLI) to collect the data. The SPSS statistical package version 26 were used and descriptive statistics was used, Pearson correlation, multiple linear regression and moderation analysis using the PROCESS macro. The findings have shown that increased cognitive overload caused by AI was significantly linked to poorer treatment adherence ($p < 0.05$), with the digital health literacy showing a significant moderating effect, lessening the negative correlation between cognitive overload and treatment adherence. The results indicate that although AI tools have significant potential, their overuse or uncontrolled application can hamper their adherence in vulnerable patients, and it is essential to promote digital health literacy to achieve the maximum effects of treatment.

Keywords: Cognition, Generalized Anxiety Disorder, Artificial Intelligence, Digital Health

Background:

The application of artificial intelligence (AI) in healthcare systems has transformed the experience of patients in terms of accessing information, managing chronic illnesses, and communication with healthcare

professionals. Chatbots, symptom checkers and personalized recommendation systems are AI-powered tools that are increasingly utilized to assist in patient education and self-management. Though these technologies have a host of benefits such as accessibility and real-time feedback, they can also present some unwanted cognitive burdens, especially when used by people with mental illnesses [1]. A cognitive overload caused by AI is one of these issues, when a person is overwhelmed with too much or too complicated information that surpasses his or her ability to process and causes confusion, stress, and poor decision-making [2].

Cognitive overload is based on Cognitive Load Theory that assumes that the capacity of the human brain to process information is limited. Learning, understanding and performance of tasks are impaired when this capacity is surpassed [3]. When applied to digital health, AI systems can produce a lot of personalized information, but redundant and sometimes conflicting information that can overwhelm users [4]. The problem is even more severe when it comes to patients with anxiety-related disorders as these patients may already be predisposed to higher sensitivity to information and uncertainty.

Generalized Anxiety Disorder is a long-term mental disorder that is marked by worry and excessive worry, restlessness, inability to concentrate and more susceptibility to stress factors [5]. People with GAD tend to indulge in extraneous information-seeking, especially on matters touching on health and this can subject them to mass AI-generated information [6]. Although this might be in a bid to minimize uncertainty, it can ironically cause anxiety and cognitive load as the information becomes too much and hard to decipher [7]. Therefore, AI-cognitive overload could be especially harmful to patients with GAD.

Adherence to treatment is an important factor of clinical outcome in GAD patients. It involves the degree to which patients adhere to the suggested pharmacological and psychological treatments, such as taking medication, attending the therapy sessions and making lifestyle changes [8]. Weak compliance is linked to higher levels of symptoms, relapse and poor quality of life [9]. Adherence is affected by a number of factors such as beliefs of the patient, health literacy, complexity of the treatment regimens and psychological state [10]. There is evidence underway that too much or improperly designed digital health data can be detrimental to compliance, causing confusion, loss of faith in medical guidance, and anxiety [11].

Although AI technologies are aimed at increasing patient engagement, they can promote non-adherence unintentionally with information overload. As an illustration, AI-driven systems might be used to display a variety of treatment modalities, conflicting prescriptions, or sophisticated health terminology without proper contextualization [12]. This may cause decisional paralysis, avoidance, and low confidence in treatment plans in patients with GAD [13]. Besides, the unlimited access to AI-generated health data can promote the habit of obsessive checks, which can strengthen anxiety and cognitive exhaustion further [14].

Digital health literacy is an important aspect that could determine the reaction of people to elements of AI-generated information. Digital health literacy is the capacity to seek, comprehend, critique and implement health data acquired via digital mediums [15]. Digital health literate people are more able to cope in a complex information, distinguish between a credible and unreliable source and make informed decisions about their health [16]. Conversely, less digitally health literate individuals might find it more difficult to decipher AI-generated information which exposes them to the risk of cognitive overload and misinformation [17].

One possible moderating factor in the relationship between information exposure and health outcomes has been found to be digital health literacy. Research has indicated that more literate people tend to have less cognitive load and tend to comply with treatment advice when using digital health tools [18]. On the other hand, confusion, misunderstanding, and decreased compliance is linked to low literacy levels [19]. Digital health literacy can be an important part of the AI-driven healthcare to reduce the adverse impact of cognitive overload on patients by facilitating better information processing and use.

Although there is an increasing trend in the application of AI in healthcare, few studies have investigated the psychological effects of AI on vulnerable groups, including patients with GAD. The majority of the literature is devoted to the advantages of AI in enhancing access and efficiency; however, not much attention is paid to its possible negative outcomes, such as cognitive overload and its implications on adherence to treatment [20].

Moreover, the moderating effect of digital health literacy on such a relationship is underresearched especially in low- and middle-income contexts in which the gap in digital access and education is stronger [21].

The interaction between cognitive overload caused by AI, adherence to treatment, and digital health literacy is crucial and should be understood to maximize the advantages of AI technologies in mental healthcare. The determination of factors that result in cognitive burden would also help design more user-friendly AI systems that display information in a concise, clear, and patient-centered way. Also, the intervention targeting the enhancement of digital health literacy can be useful in making patients more familiar with the information produced by AI and improving their adherence and clinical outcomes.

Thus, this research will assess how cognitive overload brought about by AI affects treatment adherence in GAD patients, and the intervening effect of digital health literacy. By filling in this literature gap, the study aims at helping to build safer and more effective AI-based healthcare solutions that meet the demand of patients with anxiety disorders.

Methodology:

The research utilized a cross-sectional analytical design to explore how AI-induced cognitive overload affects treatment adherence in patients with the Generalized Anxiety Disorder diagnosis, and how digital health literacy mediates the effect of AI-induced cognitive overload. The four-month research was carried out in the psychiatric outpatient units of tertiary care hospitals and in the chosen online platforms dealing with mental health and where the patients actively use the AI-based health technologies. Adult patients with a formal diagnosis of GAD based on standardized diagnostic criteria (DSM-5) made up the target population, and this guaranteed a clinical validity and homogeneity of the sample.

A sample of 120 participants was selected due to the similar cross-sectional studies and feasibility. The stratified random sampling method was adopted to guarantee sufficient representation of various important demographic strata, such as age, gender, and educational status. These variables were used to group patients into strata and randomly sample each stratum to reduce sampling bias and increase the generalizability. The inclusion criteria encompassed the age range between 18 and 60 years old, the diagnosed GAD at least six months, and the current use of AI-based digital health technologies (including chatbots or online symptom checkers) coupled with the informed consent. Patients with severe psychiatric comorbidity (e.g. a psychotic disorder), cognitive impairments, or patients who could not understand the questionnaire because of language or literacy barriers, were excluded.

A structured, self-administered questionnaire that consisted of four validated instruments was used to collect the data. The measured AI-induced cognitive overload was the AI Cognitive Overload Scale (AICOS) that includes the perceived mental load, information overload, and the inability to process AI-generated health information. The GAD-7 scale was used to assess the degree of anxiety symptoms and is a widely validated scale. The Treatment Adherence Questionnaire (TAQ) was used to measure treatment adherence and consists of questions on medication compliance, attendance of therapy sessions and behavioral adherence. The Digital Health Literacy Instrument (DHLI) was used to measure digital health literacy and assess the participants in terms of their search, understanding, appraisal, and application of digital health information. Before the actual data collection, a pilot study was done on 10% of the sample ($n = 12$) to determine the clarity, reliability and internal consistency of the tools; the change required was made. All scales had values of alpha greater than 0.70, which is acceptable reliability.

The institutional review board of the affiliated hospital provided the study with ethical approval. Everyone was enlightened on what the study was about and informed consent was signed beforehand. The data was kept in confidence and anonymity and the participants were assured that their answers would be utilized only in research.

Statistical Package for the Social Sciences (SPSS) version 26 was used to enter and analyze data. The demographic characteristics and important variables were summarized by means of descriptive statistics such

as the mean, standard deviation, frequency and percentage. The inferential statistics was used to test relationships between variables. The Pearson correlation analysis was carried out to determine the correlation between cognitive overload caused by AI, the severity of anxiety, the treatment adherence, and digital health literacy. The predictive value of the cognitive overload and other independent variables on treatment adherence was carried out through multiple linear regression analysis. Additionally, the moderation analysis has been performed based on the PROCESS macro (Model 1) created by Hayes to assess the moderating role of the digital health literacy on the linkage between cognitive overload and the adherence to the treatment. All analyses were deemed statistically significant with a p-value of below 0.05.

This research design approach guaranteed a thorough evaluation of both direct and interactive impacts of AI-related cognitive load on adherence behaviors in GAD patients and factored in the vital role of digital health literacy.

Results:

Table 1: Demographic Characteristics of Participants (n = 120)

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	18–30	42	35.0
	31–45	46	38.3
	46–60	32	26.7
Gender	Male	58	48.3
	Female	62	51.7
Educational Status	Primary	18	15.0
	Secondary	34	28.3
	Graduate	48	40.0
	Postgraduate	20	16.7
Economic Status	Low	40	33.3
	Middle	56	46.7
	High	24	20.0
Employment Status	Employed	64	53.3
	Unemployed	36	30.0
	Student	20	16.7

The majority of the respondents were between 31 and 45 years old then 18 to 30 years old with a greater number of young to middle-aged adults with Generalized Anxiety Disorder. Women were a little more as compared to men. Most of them were graduates and were in the middle economic bracket. More than half of them worked, which implies a well-functioning and fairly stable socioeconomic sample.

Table 2: Descriptive Statistics of Key Study Variables

Variable	Mean ± SD	Minimum	Maximum
AI Cognitive Overload Score (AICOS)	32.45 ± 6.21	18	48
GAD-7 Score	11.72 ± 4.05	5	20
Treatment Adherence Score (TAQ)	21.30 ± 5.10	10	35
Digital Health Literacy (DHLL)	27.85 ± 6.75	12	40

Along with moderate to high levels of AI cognitive overload, participants demonstrated moderate levels of anxiety. There was low to moderate adherence to treatment. Digital health literacy was also at a moderate

level. The difference between the scores indicates that people differ in their experience and management of digital health information.

Table 3: Correlation Matrix (Pearson Correlation)

Variables	1	2	3	4
1. AI Cognitive Overload	1			
2. GAD Severity (GAD-7)	0.42**	1		
3. Treatment Adherence	-0.51**	-0.46**	1	
4. Digital Health Literacy	-0.38**	-0.29**	0.49**	1

Anxiety severity and treatment adherence had a positive and negative relationship with AI cognitive overload, respectively. This implies that there is a correlation between increased overload and poor adherence. Digital health literacy was positively correlated with adherence and negatively correlated with overload, which means that it is protective.

Table 4: Multiple Linear Regression Analysis Predicting Treatment Adherence

Predictor Variables	B	SE	Beta	t	p-value
(Constant)	35.62	2.85	-	12.50	0.000
AI Cognitive Overload	-0.42	0.08	-0.45	-5.25	0.000
GAD Severity (GAD-7)	-0.31	0.10	-0.28	-3.10	0.002
Digital Health Literacy	0.36	0.09	0.39	4.00	0.000

The AI cognitive overload considerably decreased the adherence to the treatment, and the level of anxiety negatively influenced it, as well. Adherence was enhanced by digital health literacy. These factors had a strong impact on adherence behavior, which the model explained a huge percentage of variance.

Table 5: Moderation Analysis (PROCESS Macro Model 1)

Variable	B	SE	t	p-value
AI Cognitive Overload	-0.38	0.09	-4.22	0.000
Digital Health Literacy	0.34	0.08	4.25	0.000
Interaction (AICOS × DHLI)	0.15	0.05	3.00	0.003

Digital health literacy played a significant role in moderating the correlation between cognitive overload and adherence. The adverse impact of overload decreased with increasing literacy. This establishes its buffering ability.

Table 6: Stratified Effect of AI Cognitive Overload on Treatment Adherence

Level of Digital Health Literacy	Effect (B)	SE	t	p-value
Low (-1 SD)	-0.58	0.10	-5.80	0.000
Moderate (Mean)	-0.38	0.09	-4.22	0.000
High (+1 SD)	-0.18	0.08	-2.25	0.026

Cognitive overload was most negatively associated with adherence at low levels of literacy. This impact was lowered at moderate and high levels of literacy. Increased digital literacy obviously diminishes the detrimental effect of overload.

Discussion:

The current study explored the effects of cognitive overload caused by AI on patient treatment adherence in patients with Generalized Anxiety Disorder and the concept of digital health literacy as a mediating factor. The results showed that cognitive overload had a significant negative relationship with treatment adherence, which means that the greater the level of AI-related informational burden, the worse the adherence behaviors. These findings are consistent with the previous studies which indicated that too much exposure to complicated or unnecessary health information may hinder decision-making and decrease adherence to medical advice [22].

Anxiety disorder patients, especially GAD, are more likely to have excessive information-seeking behavior, which can expose them to AI-generated content. Such flow of information may contribute to cognitive load and cause confusion or decision paralysis. Past research has shown that people with a high level of anxiety tend to have problems with uncertainty and have higher chances of having a problem in processing massive amounts of information which at the end affects their likelihood of sticking to the treatment plans [23]. The present results prove this idea and emphasize that AI technologies, despite their usefulness, can also play a role in the psychological burden in vulnerable groups unintentionally.

The regression analysis also established that cognitive overload resulting because of AI is a marked predictor of decreased treatment adherence, notwithstanding the level of anxiety. This implies that cognitive overload is a factor itself, which has an effect on adherence outcomes. The same has been documented in digital health studies where information overload has been linked to reduced patient engagement and higher dropout rates of treatment programs [24]. Having many AI-driven suggestions, not always clearly prioritized, may cause the patients to doubt the quality of information, and thus, decrease the levels of trust and compliance [25].

One of the main contributions of this research is that it has identified the digital health literacy as a strong moderator. Moderation analysis revealed that people who had greater digital health literacy had a weaker negative association between cognitive overload and treatment adherence. This result is in line with the existing body of literature that has highlighted that people who have stronger digital competencies can better filter, interpret and apply health information [26]. The use of technologies with high digital health literacy can help patients critically assess AI-generated output, filter through the information presented and ensure that what is being conveyed to them is relevant and legitimate, and thus, reduce the negative impact of cognitive overload.

On the other hand, AI-induced cognitive overload had a more negative impact on participants that had lower scores in digital health literacy, and showed substantially worse adherence. This can be explained by the inability to comprehend complicated medical facts and failure to evaluate the credibility of the online resources. Previous research has pointed out that poor health literacy is linked to medication errors, lack of understanding and non-compliance [27]. Within the framework of AI-based healthcare, these issues can be even exacerbated, with users having to engage with advanced online interfaces and decode the recommendations provided by algorithms.

The other significant result of this study is that there is a positive relationship between digital health literacy and treatment adherence. More literate participants were more adherent which is consistent with previous findings showing that health literacy is a key determinant of health outcomes [28]. This highlights the need to include digital literacy education in patient education curricula, especially when it comes to integrating the use of digital resources in the process of providing information and support to patients with a history of chronic mental health disorders.

The results of these studies have important clinical and AI-healthcare system creation implications. The healthcare providers are advised to be conscious of the possible cognitive load of AI tools and inform patients about the proper application of these tools. Cognitive overload can be minimized by simplifying AI-generated information, eliminating redundancy, and making information clear. Also, the implementation of user-centered design concepts in AI systems can contribute to better usability and minimizing the chances of overwhelming patients [29].

Regarding the range of interventions to enhance digital health literacy, a more focused attention to the impact of AI in healthcare would be crucial regarding its optimization from the perspective of the overall public health. Patients can be empowered through educational programs, online training sessions, and easier health communication plans to better navigate AI-driven platforms. Addressing digital inequalities, especially in low- and middle-income countries, is also a matter that needs attention by policymakers because inequalities in access and literacy can put a limit on the impact of digital health interventions [30].

Although it has its contributions, there are limitations to this study. The design is also cross-sectional which restricts the establishment of causality between variables. Also, there is the possibility of response bias due to the use of self-reported measures. Longitudinal study designs ought to be implemented in future studies to understand the causal relationships and determine the long-term effects of cognitive overload caused by AI on treatment outcomes. Moreover, qualitative research can offer more information about the experiences and perceptions of patients towards AI-based health tools.

On the whole, the paper shows the dualism of AI in healthcare and reveals that although it can lead to improved patient engagement, it can also cause cognitive difficulties that adversely impact patient adherence to treatment. The key to utilizing AI to its fullest potential in mental health care, in turn, is to deal with the issues by designing the systems better and by increasing the level of digital health literacy.

Conclusion:

To summarize, AI-related cognitive overload has a severe negative effect on the adherence to treatment in GAD patients, and digital health literacy is important to protect this relationship by effectively modifying its impact. The negative effect of cognitive overload can be mitigated by enhancing the skills of patients to effectively interpret and use digital health information, and adherence outcomes can be improved. Thus, digital health literacy and optimization of the AI system design are core measures of enhancing mental health care delivery in the digital age.

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