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Predictors of pre-service teachers' attitudes toward artificial intelligence: An examination of AI literacy and anxiety

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ABSTRACT

The primary purpose of this study is to investigate the relationships among pre-service teachers' general attitudes toward artificial intelligence, their levels of AI anxiety, and their AI literacy skills. As artificial intelligence continues to transform various aspects of education, understanding the attitudes of future educators toward this technology has become increasingly important. The study group consisted of pre-service teachers studying at different universities in Türkiye, the majority of whom were female. Data collection instruments included the General Attitudes toward Artificial Intelligence Scale, the AI Anxiety Scale, the AI Literacy Scale, and a Personal Information Form designed by the researchers. Data was analyzed through Pearson correlation analysis and multiple regression analysis using SPSS and AMOS software. The findings revealed that AI literacy was positively associated with pre-service teachers' attitudes toward artificial intelligence, while AI anxiety was negatively associated with such attitudes. Furthermore, results of the multiple regression analysis demonstrated that AI literacy and AI anxiety together explained 39% of the variance in attitudes toward artificial intelligence. Given the increasing integration of artificial intelligence into educational contexts, insufficient AI literacy and elevated anxiety among pre-service teachers constitute a significant challenge for the effective adoption of this technology. This outcome highlights that both literacy and anxiety levels are critical determinants in shaping pre-service teachers' perspectives and their potential adaptation to technological innovations. The study provides practical recommendations for teacher education programs aimed at strengthening AI literacy and reducing anxiety to facilitate more effective integration of artificial intelligence into educational settings.

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Introduction

The concept of artificial intelligence was first introduced in a proposal letter presented at the Dartmouth Conference in 1956 (McCarthy, 2007). John McCarthy, often recognized as the pioneer of artificial intelligence, described it as the discipline concerned with designing and constructing machines and computer programs capable of exhibiting intelligent behavior (Rajaraman, 2014). However, the dynamic and evolutionary nature of artificial intelligence has made it increasingly difficult to establish clear and universal boundaries for the concept (Stenbom et al., 2023). Consequently, various definitions have emerged across different disciplines. For example, Obschonka and Audretsch (2020) described it as systems that develop by drawing on experiences, whereas Russell and Norvig (2016) defined artificial intelligence as the imitation of human thinking and learning processes through machines. This technological field, which aims to develop systems capable of performing the complex functions of human intelligence (Polatgil & Güler, 2023), undoubtedly exerts an influence on nearly every domain of contemporary life. Standing out with large-scale applications in sectors such as health, finance, and transportation, artificial intelligence has in recent years also gained increasing importance in the field of education.

The use of artificial intelligence in education dates to the 1960s and 1970s. This period marked a pioneering phase in the development of computer-assisted instructional systems and provided the earliest examples of technology integration in education (Temur, 2024). In particular, the 1970s saw the emergence of "Intelligent Tutoring Systems (ITS)," which aimed to offer guidance that took students' individual differences into account (Woolf, 2010). From the late 1980s onward, the integration of more advanced artificial intelligence systems into educational processes contributed to aligning instructional methods with technological innovations (Baker & Inventado, 2014). In the 1990s, learning analytics, AI-supported assessment, and adaptive learning environments came to the forefront, while in the 2000s, applications such as personalized learning, automated assessment, and the generation of instructional materials became increasingly widespread (Kamalov et al., 2023). Today, artificial intelligence undertakes multifaceted functions such as personalized learning, learning management systems, and the prediction of student achievement, serving not only to enrich instructional processes but also to support teachers' pedagogical decision-making, thereby becoming an important tool for enhancing educational efficiency (Holmes et al., 2019; Zawacki-Richter et al., 2019).

Artificial intelligence supports students and educators in education and educational management processes by facilitating the management and presentation of information, directly participating in teaching and learning processes, and assuming an instructive role that significantly contributes to education (Arslan, 2020). In personalized learning processes, AI-based systems analyze students' individual needs and generate content tailored to their learning pace and level, thereby making the learning process more efficient (Alotaibi & Alshehri, 2023; Holmes et al., 2019). In this context, Intelligent Tutoring Systems provide students with customized feedback, enabling them to progress at their own pace in complex subjects and gain in-depth learning experiences (Woolf, 2010). In addition, AI-supported tools make substantial contributions in the field of assessment and evaluation by automatically grading students' exams and assignments, delivering quick and objective results, and generating detailed reports that support teachers' pedagogical decision-making (Zawacki-Richter et al., 2019). -re, AI applications assist teachers in administrative tasks such as grading, lesson planning, and identifying students at risk of falling behind, thereby allowing educators to dedicate more time to teaching and student support (Guilherme, 2019).

Within this framework, the perspectives of individuals working in the education sector toward artificial intelligence hold a decisive significance. The adoption and effective use of educational technologies are not limited to technical infrastructure but are also closely related to users' perceptions, beliefs, and levels of readiness regarding these technologies (Teo, 2019). Positive attitudes toward artificial intelligence facilitate the integration of AI-based applications into classroom environments, thereby enhancing the effectiveness of instructional processes (Garzón-Artacho et al., 2021), whereas negative attitudes or anxieties may restrict the use of such technologies and hinder the full realization of their potential benefits (Venkatesh et al., 2003). It would therefore not be inaccurate to state that numerous factors influence attitudes toward artificial intelligence.

Theoretical Framework

Within the scope of this study, it is considered that two of these factors are AI literacy and AI anxiety. AI literacy encompasses acquiring the fundamental competencies necessary to understand, use, apply, evaluate, and create artificial intelligence (Ng et al., 2021). Becoming AI literate not only enables individuals to grasp the operational principles of AI systems but also encourages them to be conscious of the ethical and responsible use of these technologies and to evaluate them critically (Çelebi et al., 2023). From this perspective, a high level of literacy can be said to provide individuals with a more informed outlook, thereby reducing negative biases and contributing to the development of more balanced attitudes. Indeed, studies have shown that there is a significant positive relationship between attitudes toward artificial intelligence and AI literacy (Dağaşan, 2025; Karacan & Çiçek, 2024). However, in shaping attitudes toward artificial intelligence, not only literacy levels but also the anxiety individuals experience regarding AI emerges as a significant determining factor (Çelik & Dönmez, 2025).

AI anxiety can be defined as a state of panic and tension that arises from the belief, often rooted in a lack of knowledge, that the development of AI applications will lead computers and technological systems to completely replace humans in the workforce, thereby causing unemployment (Johnson & Verdicchio, 2017). The primary underlying causes of AI anxiety are largely conceptual ambiguities regarding what artificial intelligence actually is and misconceptions stemming from insufficient knowledge about the subject (Öztırak, 2023). Moreover, "The Future of Jobs" (2018) report notes that young people express concerns about the potential impacts of AI and automation technologies on the labor market. Based on these circumstances, it is expected that an individual with high AI anxiety will hold a negative attitude toward artificial intelligence. Indeed, research has demonstrated a significant negative relationship between positive attitudes toward AI and AI anxiety (Çelik & Dönmez, 2025; Deng, 2022). While AI literacy enables pre-service teachers to evaluate technology consciously, critically, and pedagogically, AI anxiety emerges as a factor that can restrict or negatively influence their attitudes toward these technologies.

Taking all these aspects into account, the aim of this study is to explore the extent to which pre-service teachers' levels of AI literacy and their AI-related anxiety serve as predictors of their attitudes toward artificial intelligence. The successful integration of AI applications into education relies not only on technical infrastructure but also on pre-service teachers' understanding, perspectives, and affective orientations toward these Technologies (Köse et al., 2024). While AI literacy enables pre-service teachers to evaluate technology consciously, critically, and pedagogically, AI anxiety emerges as a factor that can restrict or negatively influence their attitudes toward these technologies. Considering that pre-service teachers are both university students and future educators, their attitudes toward artificial intelligence play a critical role not only at the individual level but also for

the future of education. Moreover, it is evident that as pre-service teachers approach graduation, a significant dimension of their anxiety about artificial intelligence relates to concerns over unemployment (Yeniçeri & Kenan, 2025). The potential impacts of artificial intelligence on the future of the teaching profession may generate professional uncertainty and concerns about job security, which, in turn, act as determining factors in shaping pre-service teachers' attitudes toward artificial intelligence. Therefore, this study aims to examine pre-service teachers' levels of AI literacy and AI-related anxiety and their influence on attitudes toward artificial intelligence. The significance of this study lies in addressing a critical gap in the literature by simultaneously examining cognitive (AI literacy) and affective (AI anxiety) dimensions that influence teachers' technology-related attitudes, which have been shown to play a key role in technology acceptance and integration processes (Teo, 2019; Venkatesh et al., 2003). Moreover, previous research has emphasized the importance of teachers' preparedness and emotional responses for the successful implementation of AI-driven educational innovations (Holmes et al., 2019; Zawacki-Richter et al., 2019). By providing empirical evidence on how AI literacy and anxiety jointly shape pre-service teachers' attitudes, this study offers valuable insights for the design of teacher education programs and supports evidence-based policy decisions regarding the effective integration of artificial intelligence in education. In line with this purpose, the study seeks to answer the following research questions:

1. Is there a significant relationship among pre-service teachers' positive attitudes toward artificial intelligence, their AI anxiety, and their levels of AI literacy?
2. Are pre-service teachers' AI anxiety and AI literacy significant predictors of their positive attitudes toward artificial intelligence?

Method

Research Model

In this research, a correlational survey design was utilized to explore whether pre-service teachers' overall attitudes toward artificial intelligence could be predicted by their levels of AI anxiety and AI literacy. According to Karasar (2016), the correlational survey model is a methodological approach that emphasizes identifying both the presence and the degree of relationships among two or more variables.

Study Group

The study sample was composed of 223 senior students enrolled in faculties of education at various universities across Türkiye during the 2023–2024 academic year. Among the participants, 73.5% (n = 164) were female and 26.5% (n = 59) were male. To estimate the suitable sample size, a statistical power assessment was carried out. This evaluation considered a moderate effect magnitude (0.15), a 5% margin of error, 80% statistical power, and two independent predictors (students' levels of AI anxiety and AI literacy). The results indicated that at least 88 participants would be sufficient for the study. Accordingly, the sample size of 223 participants in the present study can be considered consistent with the criteria of power analysis. Participants were selected using a convenience sampling method, which involves reaching those individuals most easily accessible to the researchers and continuing until the required number of participants is obtained (Büyüköztürk, 2014).

Data Collection

First, the necessary permissions for the measurement instruments used in the study were obtained from the scale developers via email. Data was collected through face-to-face administration. In this study, a personal information form was used to gather participants' demographic information. To measure general perspectives on AI technologies, the "General Attitudes toward Artificial Intelligence Scale" was applied; to assess concerns related to AI, the "AI Anxiety Scale" was used; and to determine individuals' knowledge levels regarding AI, the "AI Literacy Scale" was administered. Prior to data collection, participants were provided with the necessary information and assured of confidentiality and data security. The data collection process then began and took approximately 15–20 minutes to complete.

This study was approved by the Ethics Committee of Maltepe University. The ethics approval was granted on 12.06.2025 under the protocol number 2025/11-01. All procedures involving human participants were conducted in accordance with institutional and national ethical standards, the Helsinki Declaration, and applicable regulations. Informed consent was obtained from all participants.

Data Collection Instruments

General Attitudes toward Artificial Intelligence Scale

The instrument created by Schepman and Rodway (2020) was intended to measure individuals' overall dispositions toward artificial intelligence, and its Turkish adaptation was conducted by Kaya et al. (2022). The scale follows a five-point Likert structure ranging from 1 (strongly disagree) to 5 (strongly agree). It includes 20 items grouped under two subdimensions. Example items include: [Item 1]: "I am interested in using artificial intelligence systems in my daily life." [Item 4]: "Artificial intelligence may provide new economic opportunities for this country." The scale is evaluated in two dimensions: positive attitudes toward artificial intelligence and negative attitudes toward artificial intelligence. The negative attitude subdimension is coded in reverse, meaning that higher scores reflect more favorable attitudes toward AI. For the purposes of this study, the validity and reliability of the instrument were evaluated. To assess construct validity, a Confirmatory Factor Analysis was performed. The analysis results revealed that the model fit indices were within acceptable ranges ($\chi^2/df = 2.62$, RMSEA = .05, SRMR = .04, CFI = .91). For reliability, the Cronbach's alpha internal consistency coefficient was calculated as .83.

AI Anxiety Scale

The instrument created by Wang and Wang (2019) was developed to assess individuals' anxiety levels concerning artificial intelligence, and its Turkish adaptation was carried out by Terzi (2020). The scale employs a five-point Likert structure, ranging from 1 (strongly disagree) to 5 (strongly agree). It is composed of 16 items distributed across four subdimensions. Example items include: [Item 5]: "I feel anxious about learning how to interact with an artificial intelligence technique/product." [Item 16]: "I find humanoid artificial intelligence techniques/products (e.g., humanoid robots) intimidating." For use in this study, the validity and reliability analyses of the scale were conducted. Confirmatory Factor Analysis was applied to test construct validity. The results indicated that the model fit indices were within acceptable limits ($\chi^2/df = 2.58$, RMSEA = .05, SRMR = .04, CFI = .91). For reliability, Cronbach's alpha internal consistency coefficient was calculated as .93.

AI Literacy Scale

The scale developed by Wang et al. (2023) was designed to measure individuals' levels of AI literacy. Its Turkish adaptation was carried out by Polatgil and Güler (2023). The scale employs a five-point Likert format ranging from 1 (strongly disagree) to 5 (strongly agree). It consists of 12 items and four subdimensions. Example items include: [Item 4]: "I can skillfully use AI applications or products to assist me in my daily tasks." [Item 10]: "I always adhere to ethical principles when using AI applications or products." For use in the present study, validity and reliability analyses were conducted. Confirmatory Factor Analysis was performed to test construct validity. The analysis results showed that the model fit indices were within acceptable limits ($\chi^2/df = 2.72$, RMSEA = .06, SRMR = .03, CFI = .95). For reliability, Cronbach's alpha internal consistency coefficient was calculated as .72.

Table 1

Confirmatory Factor Analysis Fit Indices and Reliability Coefficients of Scales

Scales	χ^2/df	RMSEA	SRMR	CFI	Cronbach's α
General Attitudes toward Artificial Intelligence	2.62	.05	.04	.91	.83
AI Anxiety	2.58	.05	.04	.91	.93
AI Literacy	2.72	.06	.03	.95	.72

Data Analysis

First, the data collected through the measurement instruments were transferred into digital format and analyzed using SPSS 25.0 and AMOS 24.0. A significance level of .05 was adopted in the study. Before beginning statistical procedures, the 223 data entries were uploaded into SPSS 25.0. A missing data check was conducted, and no deficiencies were identified. Outlier analysis was then performed by calculating z-scores, and values between -4 and +4 were considered to determine outliers (Mertler & Vannatta, 2016). Since no data were found outside this range, the analysis phase proceeded. The reliability and validity of the General Attitudes toward Artificial Intelligence Scale, the AI Anxiety Scale, and the AI Literacy Scale used in the study were examined. For validity analyses, Confirmatory Factor Analysis was conducted using AMOS 24.0, while reliability analysis was carried out by calculating Cronbach's alpha internal consistency coefficients with SPSS 25.0. The analyses indicated that the data collection instruments were both reliable and valid. A normality test was first applied for the analyses. The results showed that the data were within the accepted reference ranges (Bandalos & Finney, 2019). Once normal distribution was confirmed, Pearson correlation analysis was conducted to explore the relationships among the variables. Furthermore, multiple linear regression analysis was employed to assess the impact of AI literacy and AI anxiety on attitudes toward artificial intelligence. Before performing the regression analysis, the necessary assumptions were examined and validated (Field, 2009; Tabachnick & Fidell, 2019; Ullman, 2013).

Findings

The mean scores, minimum and maximum values, standard deviations, as well as skewness and kurtosis values obtained from the scales administered to the participants within the scope of the study are presented in Table 1.

Table 2

Descriptive Statistics for the Research Variables

Variables	n	Mean	Min.	Max.	Sd.	Skewness	Kurtosis
Attitudes toward artificial intelligence	223	69.76	20.00	100.00	10.49	-.456	.498
AI anxiety	223	47.23	16.00	80.00	12.71	-.557	5.287
AI literacy	223	45.27	24.00	59.00	6.49	.354	.354

To determine whether the data obtained in the study met the assumption of normality, the skewness and kurtosis values presented in Table 1 were examined. The skewness and kurtosis coefficients of each variable were found to fall within the reference range of -2.00 to +7.00 (Bandalos & Finney, 2019). This finding indicates that the variables exhibited a normal distribution and that the assumption of normality was satisfied. The correlation coefficients calculated to reveal the level and direction of the relationships among the variables are presented in detail in Table 2.

Table 3

Correlation Values among the Variables

Variables	(1)	(2)	(3)
(1) Attitudes toward artificial intelligence	-		
(2) AI anxiety	-.542**	-	
(3) AI literacy	.409**	-.191**	-

Examining the correlation values presented in Table 2, it is observed that there is a significant negative relationship between positive attitudes toward artificial intelligence and AI anxiety (r = -.542, p < .01). In contrast, a significant positive relationship is found between AI literacy and positive attitudes toward artificial intelligence (r = .409, p < .01). Furthermore, there is also a significant negative relationship between AI literacy and AI anxiety (r = -.191, p < .01). These results indicate that there is no multicollinearity problem among the variables. To determine the extent to which AI anxiety and AI literacy influence pre-service teachers' attitudes toward artificial intelligence, a multiple linear regression analysis was conducted. The results of the multiple linear regression analysis are presented in Table 4 below.

Table 4

Findings from the Multiple Regression Analysis of AI Anxiety and AI Literacy in Relation to Positive Attitudes toward Artificial Intelligence

	R	R^2	*F*	*B*	*SE*	*β*	*t*	p
Constant				65.330	4.815		13.567	.000
AI anxiety				.513	.044	-.481	-8.976	.000
AI literacy	.62	.39	70.555	-.397	.087	.317	5.920	.000

**p < .01. Dependent variable: Positive attitudes toward artificial intelligence

As shown in Table 4, the constructed model was found to be significant, with AI anxiety and AI literacy together explaining approximately 39% of the total variance in pre-service teachers' attitudes toward artificial intelligence (F = 70.555, p < .001). The model indicated that AI anxiety and AI literacy had a substantial effect size on attitudes toward AI (.26 < R^2) (Cohen, 1988). Examination of the variables revealed that AI anxiety significantly and negatively predicted pre-service teachers' attitudes (β = -0.481, t = -8.976, p < .001), meaning that as anxiety levels increased, attitudes toward

artificial intelligence became more negative. In contrast, AI literacy significantly and positively predicted attitudes ($\beta = 0.317$, $t = 5.920$, $p < .001$), indicating that higher literacy levels were associated with more positive attitudes toward artificial intelligence.

Discussion and Conclusion

Identifying the factors that shape pre-service teachers' attitudes toward artificial intelligence is important for understanding and effectively utilizing AI in education (Saatçioğlu & Topsakal, 2025). Individuals' knowledge levels about AI technologies influence their perspectives toward these technologies (Kaya et al., 2022). In this regard, the present study examined the effects of AI anxiety and AI literacy on pre-service teachers' positive attitudes toward artificial intelligence. The analyses revealed that AI literacy and AI anxiety together accounted for 13% of the variance in attitudes toward AI. This finding suggests that pre-service teachers' positive attitudes toward artificial intelligence are influenced not only by their individual levels of anxiety and knowledge but also by how AI is positioned within educational processes, the extent to which it is integrated into curricula, and their expectations regarding their professional futures.

According to the results of the study, a significant positive relationship was found between AI literacy and attitudes toward artificial intelligence. Furthermore, AI literacy was determined to have a significant and positive effect on attitudes toward AI. In a study conducted by Özden et al. (2025), it was found that individuals with greater knowledge about artificial intelligence exhibited more positive attitudes toward it. A multinational study similarly revealed that both university students and academics who used ChatGPT generally held positive attitudes (Abdaljaleel et al., 2024). In another study conducted in Türkiye with 235 pre-service teachers, a significant positive relationship between AI literacy and attitudes toward artificial intelligence was identified (Mart & Kaya, 2024). In the same study, interviews with nine pre-service teachers showed that their desire to receive practical AI training during their university education was grounded not only in the expectation that learning and using AI would provide them with an important advantage in their academic and professional lives but also in the belief that it would contribute to their personal development. Based on these findings, AI literacy emerges as a determining factor in the development of positive attitudes toward artificial intelligence among pre-service teachers. As their knowledge and awareness of AI technologies increase, pre-service teachers tend to perceive AI as a more functional, innovative, and supportive tool in the teaching and learning process. Particularly in their professional identity development, the fact that pre-service teachers regard AI not merely as a technical innovation but also as an opportunity to transform pedagogical practices further underscores the significance of AI literacy in this context.

Another important finding of the study is the identification of a significant negative relationship between pre-service teachers' AI anxiety and their attitudes toward artificial intelligence. This indicates that as anxiety levels increase, pre-service teachers develop more negative perspectives toward AI. Similar findings are also reported in the literature, showing that AI anxiety negatively affects attitudes toward artificial intelligence. In his study, Öztırak (2023) emphasized that AI anxiety is an important factor in shaping individuals' general attitudes toward technology. Moreover, it has been suggested that there may be a negative relationship between having knowledge about AI and experiencing AI anxiety (Othman et al., 2021). AI anxiety can weaken individuals' learning motivation, adaptability to new technologies, and openness to innovation, thereby acting as a barrier to the integration of artificial intelligence into educational settings (Howard et al., 2021). Considering that pre-service teachers are university students and will soon

become active agents in educational processes, this finding becomes even more critical. Their level of technology acceptance will directly determine the effective use of AI in classroom instructional processes. During the integration of AI-based educational tools into learning environments, teachers' attitudes and beliefs play a decisive role (Güngör & Öztürk, 2025). Pre-service teachers who develop positive attitudes are more likely to adopt practices that consider students' individual differences and make learning processes more efficient and inclusive. In contrast, those with high levels of anxiety may perceive the use of AI-supported tools as unnecessary, risky, or a source of loss of control (Erdoğdu & Çakır, 2024). This situation can affect not only the professional competencies of pre-service teachers but also the ways in which students experience technology. Taken together, the findings of the present study align with prior research indicating that pre-service teachers demonstrate low to moderate levels of competence across awareness, use, evaluation, and ethical dimensions of artificial intelligence, suggesting that these competencies are still developing during teacher education (Çam et al., 2021; Erdoğdu & Çakır, 2024; Lim, 2023; Uzun, 2025). In a research context where educators' perspectives remain insufficiently addressed in the AI in education literature (Zawacki-Richter et al., 2019), the current results highlight pre-service teacher education as a critical period for examining AI literacy and AI-related anxiety as key factors shaping future educational practices.

Limitations

This study has several limitations. First, it was conducted with a sample consisting solely of pre-service teachers; therefore, the findings cannot be generalized to all teachers or other professional groups. In addition, the study employed a quantitative design, and the relationships among attitudes, anxiety, and literacy regarding artificial intelligence were evaluated based on numerical data. This approach limits the in-depth understanding of participants lived experiences and perceptions. Since the instruments used were self-report scales, the possibility of social desirability bias or subjective evaluation errors in participants' responses cannot be overlooked.

Implications

Considering the limitations of the study, several recommendations can be made for future research. First, studies conducted with broader and more diverse samples that include not only pre-service teachers but also academics, in-service teachers, and educators working at different levels of education would increase the generalizability of the findings and contribute to developing a more holistic perspective on artificial intelligence in education. In addition, the use of qualitative methods or mixed designs could provide a deeper understanding of pre-service teachers' attitudes and anxieties toward AI. Longitudinal research would also be valuable in revealing how anxiety and literacy levels change over time and how these changes influence attitudes.

Based on the findings of this study, several recommendations can be developed for policymakers and pre-service teachers. First, teacher education programs could integrate courses, seminars, and practical workshops aimed at developing AI literacy. Such initiatives would not only provide technical knowledge but also foster a critical and ethical perspective on the pedagogical use of artificial intelligence. For policymakers, it is important to develop strategies that support the integration of AI technologies into the education system. For pre-service teachers, activities designed to reduce anxiety—such as awareness programs, guidance services, and professional learning communities based on experience sharing—are recommended. In this way, pre-service teachers may begin to perceive AI not as a threat but as a tool that supports their professional development and enhances students' learning processes.

Declarations

Ethics statement: This study was approved by the Ethics Committee of Maltepe University. The ethics approval was granted on 12.06.2025 under the protocol number 2025/11-01. All procedures involving human participants were conducted in accordance with institutional and national ethical standards, the Helsinki Declaration, and applicable regulations. Informed consent was obtained from all participants.

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