MEGA INSTITUTE FOR ADVANCE RESEARCH AND DEVELOPMENT

Journal of Arts and Linguistics Studies
ISSN Print 2959-0957 ISSN Online 2959-0965
Volume 4 Issue 7 2026
Pages 57-87
Open Access

Artificial Intelligence for Stuttering Assessment and Intervention: Perspectives from Pakistani Speech-Language Pathologists

Publication Details
Paper Received:
June 20, 2026
Paper Accepted:
July 02, 2026
Paper Published:
July 05, 2026

Hafiz Rukhsar Ahmed
PhD Scholar, Special Education, Allama Iqbal Open University, Islamabad. Email: hafizrukhsarahmad@gmail.com
Faiza Aziz
MS Speech-Language Pathology, Riphah International University, Lahore, Speech-Language Pathologist, Huzaifa Therapy Home, Askari 10, Lahore, Speech-Language Pathologist, Private Clinic, Paragon City, Lahore, Pakistan, Email: ummaykhadijah@gmail.com
Sayyeda Rabia Basri (Corresponding Author**)**
Lecturer, Department of Special Education, University of Education, Lahore, Pakistan. Email: rabia.basri@ue.edu.pk
Syed Tariq Shah
Assistant Professor, Riphah International University, Islamabad, Pakistan. Email: Tariqshahts564@gmail.com

Article DOI: https://doi.org/10.71281/jals.v4i7.674

Abstract
Artificial intelligence (AI) is increasingly being integrated into speech-language pathology, yet evidence regarding clinicians' perspectives in developing countries remains limited. This study examined Pakistani Speech-Language Pathologists' (SLPs) perceptions of AI for stuttering assessment and intervention. A quantitative cross-sectional survey was conducted among 133 practicing SLPs using a validated questionnaire measuring knowledge and awareness, perceived usefulness, perceived ease of use, clinical effectiveness, ethical concerns, and implementation barriers. Descriptive statistics, independent-samples t-tests, and one-way ANOVA were performed. Participants demonstrated moderate knowledge of AI (M = 3.50, SD = 0.90) but reported high perceived usefulness (M = 4.09, SD = 0.80) and clinical effectiveness (M = 4.05, SD = 0.83). Ethical concerns (M = 4.48, SD = 0.64) and implementation barriers (M = 4.13, SD = 0.79) were also strongly endorsed. Gender differences were not statistically significant, whereas perceptions varied significantly across clinical experience groups. The findings highlight the need for professional training, ethical governance, institutional support, and locally relevant AI technologies to facilitate responsible integration of AI into speech-language pathology practice in Pakistan.

Keywords: Artificial intelligence; Stuttering; Speech-language pathology; Technology acceptance; Clinical practice; Pakistan.

Published by MIARD. Copyright: © the author(s). This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY NC) license (https:// creativecommons.org/licenses/by/ 4.0/).

1. Introduction

The application of artificial intelligence (AI) in healthcare is a rapidly evolving field that holds the promise of transforming the field in many ways, particularly in the areas of diagnostics, clinical decision-making, personalized treatment, and service delivery in many medical specialties. AI technologies like speech analysis, natural language processing, machine learning, and deep learning have shown great promise in facilitating the evaluation, monitoring, and treatment of communication disorders in the field of rehabilitation sciences (Topol, 2019; Davenport & Kalakota, 2019). In the past, speech-language pathology (SLP) has been a primary field for using perceptual and acoustic analyses to inform clinical practice, and is now making increased use of AI-supported tools to streamline and objectify clinical practice (König et al., 2022). Stuttering is one of the most complex communication disorders, making it an attractive field for AI applications related to assessment and intervention.

Stuttering is a fluency disorder of the nervous system, defined by a disruption of the speech stream, such as blocks, prolongations and repetitions, and possibly including other secondary physical behaviors and emotional distress (American Psychiatric Association [APA], 2022; Guitar, 2019). Stuttering occurs in about 5% of children in the early language acquisition stage and almost 1% of the world's population remains stutterers until adulthood (Yairi & Seery, 2022). In addition to difficulty with speech, stuttering often has an impact on school grades, work and career, social involvement, and mental health, leading to diminished quality of life (Craig & Tran, 2014). Therefore, the early identification, accurate assessment, and effective intervention continue to be key goals for speech-language pathologists.

Traditional methods of assessing stuttering rely on the clinician's observations, standardized assessment tools, analysis of speech samples, and client interviews. While these are still considered the clinical standards of practice, they can be time-consuming and inter-rater unreliable, especially when measuring nuanced dis-fluency patterns and changes to treatment outcomes over time (Guitar, 2019). In addition, it is important to carry out comprehensive assessment, which necessitates a broad spectrum of clinical skills and repeated evaluations, which may be challenging in resource-limited healthcare systems. The difficulties of these problems have led to research aimed at discovering technologies using AI that can assist clinicians through automatic speech recognition, acoustic feature extraction, and objective assessment of fluency characteristics (König et al., 2022). The advances in AI have contributed to the creation of automatic systems designed to detect stuttering events, classify speech disfluencies, track treatment progress, and provide therapeutic feedback. Using acoustic, linguistic, and temporal speech features, machine learning algorithms have been shown to have high accuracy in differentiating fluent and disfluent speech (Bień et al., 2023). Likewise, deep learning models have demonstrated great potential in the recognition of intricate speech patterns and information that could be missed in standard perceptual assessment (Mitra et al., 2022). AI-powered mobile apps and telepractice platforms are also helping to broaden access to speech-language therapy by allowing for ongoing home-based practice and monitoring of client progress (Fagherazzi et al., 2020). Collectively, these developments suggest that AI has the potential to complement rather than replace clinical expertise by providing objective, efficient, and data-driven support throughout the assessment and intervention process.

Although all these technological developments have occurred, the adoption of AI requires a high level of acceptance, confidence, and willingness on the part

of clinicians for effective implementation in clinical practice. According to the Technology Acceptance Model (TAM), the perceived usefulness and perceived ease of use are the most important factors affecting professionals' intentions to use new technologies (Davis, 1989). Many healthcare research studies have shown that clinicians are more likely to embrace AI when they believe that the technology is useful, easy to use, reliable, and fits their clinical practices (Venkatesh et al., 2003; Alam et al., 2022). On the other hand, ethical concerns, transparency of algorithms, privacy, accountability, and professional autonomy are often the barriers to the acceptance of AI in healthcare (European Commission, 2021). Thus, it is important to grasp clinicians' point of view before taking AI-based systems to the clinic.

Speech-language pathologists (SLPs) have demonstrated enthusiasm and apprehension when it comes to AI integration within their field. Prior studies have shown that speech-language pathologists are aware of the potential benefits of AI for enhanced diagnostic accuracy, therapy planning, clinical documentation, and service accessibility. They do, however, voice concerns about inadequate training, lack of technical know-how, a lack of culturally appropriate AI tools, and uncertainty about professional responsibilities when the recommendations made by AI conflict with clinical judgment (Fong et al., 2023; König et al., 2022). The results highlight the need for both technological advancements and clinician training, institutional backing, and regulatory measures to ensure the successful adoption of AI.

AI adoption in the context of speech-language pathology is filled with unique opportunities and challenges in Pakistan. Pakistan has a significant lack of qualified speech-language pathologists compared to the population, and specialized speech and language services are limited to the big cities. Access to rehabilitation services remains limited and inequitable nationwide, as are services

for the rehabilitation of people with disabilities, due to financial barriers and increasing demands for tele-rehabilitation care (World Health Organization, 2022). At the same time, the widespread penetration of smartphones, growing Internet connectivity, and national interest in digital health technologies create a conducive environment for the integration of AI-assisted clinical tools within rehabilitation services (Pakistan Telecommunication Authority, 2024). However, there is limited empirical evidence on the preparedness of Pakistani speech-language pathologists to embrace AI in the assessment and intervention of stuttering.

In recent years, the literature has largely been dedicated to creating AI algorithms or assessing the technical function; in comparison, little research has examined the views of clinicians about the use of AI, especially in low- and middle-income countries. Furthermore, a comprehensive study on the knowledge, attitudes, perceived usefulness, ethical concerns, implementation barriers, and behavioral intentions of speech-language pathologists in Pakistan towards the use of AI in stuttering management has not been conducted. This is important as these orientations can be a significant factor in the success of the implementation of the technology and its adoption into clinical practice (Davis, 1989; Venkatesh et al., 2003).

This study seeks to explore the views of speech-language pathologists in Pakistan on the application of AI in stuttering assessment and intervention. In particular, the study examines clinicians' knowledge and awareness of AI, perceived usefulness, perceived ease of use, perceived clinical effectiveness, ethical considerations, barriers to implementation, preparedness for adopting, and behavioral intentions toward using AI-based technologies in professional practice. The results will offer insights that will help in policy formulation, professional

training, strategies for incorporating AI into SLP services, and future research in this field.

1.1. Research Objectives

- To assess Speech-Language Pathologists' knowledge and awareness of artificial intelligence applications in stuttering assessment and intervention.
- To examine their perceptions of the usefulness, ease of use, and clinical effectiveness of artificial intelligence in stuttering management.
- To identify ethical concerns and implementation barriers associated with the adoption of artificial intelligence in speech-language pathology practice.
- To examine whether perceptions of artificial intelligence differ according to gender and clinical experience.

2. Literature Review

Artificial Intelligence (AI) is a revolutionary technology in health care that provides innovative solutions for assessment, diagnosis, treatment planning, and clinical decision-making. The use of AI in speech-language pathology (SLP) has become a growing focus due to its potential for automating speech analysis, enhancing diagnostic precision, tailoring therapeutic approaches, and aiding in clinical documentation. Advances in machine learning, deep learning, natural language processing, and automatic speech recognition have brought numerous communication disorders into the fold of AI applications, such as stuttering. While AI is not a replacement for speech-language pathologists (SLPs), it can have a significant impact on clinical efficiency and support evidence-based practice (EBP) (Balo et al., 2025; Deka et al., 2024).

Stuttering is a neuro-developmental fluency disorder that involves involuntary repetitions, prolongations, and blocks that disrupt the normal flow of

speech. The traditional assessment is reliant on clinician observation, standardized assessment instruments, and perceptual judgments, which can be subjective and time-consuming. With the advent of AI systems, there are now objective ways to detect speech disfluency that consider more consistent acoustic and linguistic characteristics. In recent years, systematic reviews have shown the potential of computational intelligence models for detecting stuttering events and the classification of speech samples, both in supporting clinicians in the assessment process and in alleviating the workload of manual classification (Alnashwan et al., 2023; Chaudhary et al., 2022).

AI is not only used for assessment, but it is also being utilized in stuttering intervention. The technology-based rehabilitation solutions involve mobile applications, virtual reality, biofeedback systems, telepractice, altered auditory feedback devices, and AI-assisted speech monitoring platforms. There is evidence that these technologies enhance speech fluency, make treatment more accessible, and encourage patient involvement. Additionally, AI systems can offer instant feedback, track performance in real time, and customize therapy activities based on a participant's performance, thereby supplementing, not being a replacement for, traditional therapy and human expertise (Chaudhary et al., 2022; Deka et al., 2024).

Although technological innovation is advancing rapidly, successful implementation largely depends on clinicians' acceptance of AI. The Technology Acceptance Model (TAM) suggests that one's attitudes toward technology use are largely determined by perceived usefulness and perceived ease of use. Clinicians are more inclined toward using AI in healthcare when they think it improves clinical practice without adding to their workload. Research with speech-language pathologists has shown that a positive attitude toward AI is correlated with increased intentions to use AI in documentation, assessment, and intervention

planning. However, fewer clinicians report experience using AI in their clinical practice despite their awareness of its potential advantages (Austin et al., 2025; Basri et al., 2025).

Awareness and knowledge are also key drivers of AI adoption. While many clinicians are aware of the basics of AI, they may not be familiar with more sophisticated AI tools, such as machine learning algorithms and automated speech analysis systems. Education in professional training is inadequate, and opportunities for further training are restricted, leading to less clinicians' confidence in using AI-based tools. Therefore, researchers stress the need to provide a structured curriculum for AI education, hands-on workshops, and professional guidelines to enhance technological competence for speech-language pathologists (Austin et al., 2025; Balo et al., 2025).

However, a major challenge for implementing AI in speech-language pathology is the ethical issues associated with its use. AI systems analyze vast amounts of sensitive speech and health data, which pose privacy concerns, informed consent issues, cyber security risks, algorithmic transparency, and algorithmic bias. Additionally, clinicians worry that algorithm-driven decisions will lead to a decreased level of autonomy or make recommendations that are incorrect if the algorithms are developed from non-representative data sets. Thus, it is recommended to keep AI systems transparent, explainable, and ethically controlled, and to maintain clinician oversight (Austin et al., 2025; Balo et al., 2025).

Ethical issues are not the only implementation barriers. The high cost of software, poor digital infrastructure, and lack of Internet access, weak institutions, and the absence of local AI products are still major challenges for the mass adoption of AI, especially in low and middle-income countries. Research among speech-language pathologists in Pakistan has revealed a lack of affordability, of

local availability of relevant software, and of sufficient training as major barriers to the use of technology in routine clinical practice. This study underscores the importance of developing affordable AI solutions to meet the unique needs of resource-limited healthcare systems (Aziz et al., 2024; Basri et al., 2025).

Individual and organizational readiness are key in successful AI integration. To effectively implement AI technologies in healthcare organizations, they need to have robust infrastructure, technical support, institutional policies in place, and a trained workforce. The findings of the study on digital health interventions in Pakistan indicate that the overall attitude of healthcare providers towards digital innovations is positive, but there are significant variations in organizational readiness among different healthcare institutions with varying technological resources and capacities to implement them. Digital infrastructure and policy development to build institutional readiness for sustainable AI adoption will then be crucial (Tahir et al., 2024).

There is also evidence that currently suggests that telepractice and AI-enhanced rehab can help enhance access to speech-language services, especially for those in less-resourced areas. Technology-enabled interventions: Decrease travel needs, allow for remote monitoring, and support ongoing clinician-patient communication. For a few communication disorders, systematic reviews comparing telepractice with in-person speech and language pathology services have found similar outcomes to in-person therapy, which indicates that AI-supported telepractice could be a more important part of the future of speech and language pathology rehabilitation services (Telehealth Systematic Review, 2024). While there is an increasing amount of international research on the use of AI, evidence of its implementation among speech-language pathologists (SLPs) in Pakistan is limited. Previous studies in Pakistan mainly focus on technological rehabilitation practices or attitudes towards digital tools in general, and few studies

have integrated all the theoretical components of knowledge, perceived usefulness, ease of use, ethical concerns, and barriers to implementation, organizational readiness, and behavioral intentions. Addressing these gaps is crucial to ensure that future educational initiatives, institutional policies, and strategies for implementing AI in Pakistan are informed. The current research thus explores the views of Pakistani speech-language pathologists on the use of AI in assessing and intervening with stutterers, while also exploring factors associated with the acceptance and possible integration of AI in the clinical setting.

3. Research Methodology

3.1. Research Design

The study employed a quantitative cross-sectional survey design to explore Pakistani Speech-Language Pathologists' attitudes and perceptions toward AI in the assessment and intervention of stuttering. This design was suitable for the assessment of knowledge and awareness, perceived usefulness, perceived ease of use, clinical effectiveness, ethical concerns, and implementation barriers.

3.2. Population and Sample

This study involved 133 working SLPs from hospitals, clinics, rehabilitation centers, universities, special education institutions, and private practice in Pakistan. Students, interns, non-practicing professionals, and incomplete responses were not included; only those SLPs who were qualified and practicing were included.

3.3. Sampling Technique

Data collection was by purposive sampling. The questionnaire was distributed using professional contacts, clinical institutions, Universities, rehabilitation centers, email, and social media groups related to SLPs.

3.4. Research Instrument

A structured self-administered questionnaire was used to obtain data, which was developed following the guidelines of the Technology Acceptance Model (TAM) and literature pertinent to the study of Artificial Intelligence in speech-language pathology. The questionnaire included 10 demographic questions and 46 items covering six constructs: AI knowledge and awareness (6 items), perceived usefulness (8 items), perceived ease of use (6 items), clinical effectiveness (8 items), ethical concerns (8 items), and implementation barriers (8 items). Answers were given on a 5-point Likert scale (from 1-Strongly Disagree to 5-Strongly Agree). The questionnaire items were derived from existing studies on the acceptance of technology and the adoption of AI and tailored to the context of AI-assisted stuttering assessment and intervention in Pakistan. The instrument was first checked by speech-language pathology and research methodology experts to ensure content validity and relevance before the main survey.

3.5. Validity and Reliability

The questionnaire was reviewed by three experts, including speech-language pathologists, a research methodologist, and a digital health expert, to provide content validity and to ensure relevance and clarity of the items. Preliminary research was done before the primary survey to test the clarity and reliability of the instrument. Cronbach's alpha coefficient was used to test for internal consistency. Reliability analysis showed good internal consistency of all six constructs with Cronbach's alpha values ranging from .80 to .91. That is, the coefficients for Knowledge and Awareness were .83, Perceived Usefulness was .89, Perceived Ease of Use was .80, Clinical Effectiveness was .91, Ethical Concerns was .88, and Implementation Barriers was .86. The overall questionnaire had a very high reliability (Cronbach's $\alpha = .88$), which made it suitable for the main study.

3.6. Data Collection and Analysis

Data were gathered by using Google Forms and printable questionnaires. Responses were invited but were only analyzed if they were complete. The data were analyzed with SPSS. Frequencies, percentages, means and standard deviations were calculated. Independent-samples t-tests and one-way ANOVA, with a statistical significance criterion of $p < .05$.

3.7. Ethical Considerations

Informed consent was obtained from all participants. Data were collected; anonymity, confidentiality, and voluntary participation were assured; and data were only used for academic purposes.

4. Results and Analysis

Table 1: Demographic Characteristics of the Respondents (N = 133)

Variable	Category	n	%
Gender	Male	29	21.8
	Female	104	78.2
Age (Years)	21–30	48	36.1
	31–40	56	42.1
	41–50	22	16.5
	Above 50	7	5.3
Highest Qualification	BS Speech-Language Pathology	48	36.1
	MS/MPhil	69	51.9
	PhD	16	12.0

Variable	Category	n	%
Clinical Experience	Less than 2 Years	24	18.0
	2–5 Years	47	35.3
	6–10 Years	38	28.6
	More than 10 Years	24	18.0
Province of Practice	Punjab	82	61.7
	Sindh	21	15.8
	Khyber Pakhtunkhwa	16	12.0
	Balochistan	5	3.8
	Gilgit-Baltistan	4	3.0
	Azad Jammu & Kashmir	5	3.8
Employment Setting	Government Hospital	24	18.0
	Private Hospital	18	13.5
	Rehabilitation Centre	34	25.6
	University	12	9.0
	Private Clinic	36	27.1
	NGO/Other	9	6.8

Table 1 presents the demographic characteristics of the 133 Speech-Language Pathologists who participated in the study. Most respondents were female (78.2%)

and aged 31–40 years (42.1%). Over half of the participants had an MS/MPhil (51.9%), and the highest frequency group had 2–5 years of clinical experience (35.3%). Most of the participants were from Punjab (61.7%) followed by Sindh and Khyber Pakhtunkhwa. In terms of employment, the majority worked in private clinics (27.1%) and rehabilitation centers (25.6%), suggesting that participants were a representative sample of Speech-Language Pathologists with a variety of experience and practice locations in Pakistan.

Table 2. Descriptive Statistics of Speech-Language Pathologists' Knowledge and Awareness of Artificial Intelligence.

Statement	Mean	SD
I am familiar with AI applications in speech-language pathology.	**2.99**	**0.89**
I understand how AI can assist in stuttering assessment.	**3.13**	**0.94**
I understand how AI can support stuttering intervention.	**3.20**	**0.97**
I have sufficient knowledge to evaluate AI-based clinical tools.	**3.21**	**1.02**
AI is becoming an important component of modern speech-language pathology.	**4.08**	**0.83**
I would like additional training on AI applications.	**4.36**	**0.76**
Overall Mean	**3.50**	**0.90**

Table 2 presents descriptive statistics on Speech-Language Pathologists' knowledge and awareness of AI in speech-language pathology (SLP). The results show that the mean scores are in the moderate range for knowledge about the use of AI, from 2.99 to 3.21. Respondents strongly agreed, however, that AI is becoming an important part of speech-language pathology (M = 4.08) and that

there is a high need to provide more training in AI (M = 4.36). The overall mean score (M = 3.50, SD = 0.90) indicates that Pakistani Speech-Language Pathologists are aware of the increasing significance of AI, but their expertise in and confidence with AI-based clinical instruments are moderate, implying the need for more education and professional training.

Table 3. Descriptive Statistics of Speech-Language Pathologists' Perceived Usefulness of Artificial Intelligence

Statement	***M***	***SD***
AI improves assessment accuracy.	4.16	0.81
AI reduces workload.	3.89	0.88
AI improves treatment planning.	4.08	0.79
AI monitors therapy progress.	4.12	0.76
AI improves documentation.	3.94	0.87
AI assists speech analysis.	4.18	0.74
AI enhances individualized therapy.	4.10	0.80
Overall clinical practice improves.	4.21	0.72
Overall Mean	**4.09**	**0.80**

Table 3 provides the descriptive statistics of the Speech-Language Pathologists' perceived usefulness of AI in the assessment and intervention of stutter. The results show that the perceived usefulness is high ranging from 3.89 to 4.21 mean scores. AI's potential to enhance overall clinical practice and to help with objective speech analysis was rated as the highest, with Mean scores of 4.21 (SD = 0.72) and 4.18 (SD = 0.74), respectively. The overall mean score (M = 4.09, SD = 0.80) indicated that Pakistani Speech-Language Pathologists in general agree that AI is

a useful tool in improving the quality, efficiency, and effectiveness of the assessment and intervention for stuttering.

Table 4. Descriptive Statistics of Speech-Language Pathologists' Perceived Ease of Use of Artificial Intelligence

Statement	***M***	***SD***
AI systems are easy to learn.	3.71	0.91
AI is easy to integrate into clinical practice.	3.58	0.94
AI-generated reports are easy to interpret.	3.63	0.89
Learning AI requires little effort.	3.54	0.97
AI tools are user-friendly.	3.76	0.86
I feel comfortable using AI in clinical practice.	3.61	0.92
Overall Mean	**3.64**	**0.92**

Table 4 shows the descriptive statistics for Speech-Language Pathologists' perceived ease of use in the assessment and intervention of stuttering with AI. The findings suggest a positive perception of the usability of AI, ranging from moderate to high with mean values between 3.54 and 3.76. Respondents most strongly agreed that AI tools are user-friendly (M = 3.76, SD = 0.86) and easy to learn (M = 3.71, SD = 0.91). Slightly lower levels of scores for integrating AI into clinical practice (M = 3.58, SD = 0.94) and the effort required to learn AI (M = 3.54, SD = 0.97) indicate that some clinicians foresee practical challenges. The overall mean score (M = 3.64, SD = 0.92) suggests that overall, Pakistani Speech-

Language Pathologists have a positive perception of the use of AI, with a few more training sessions and technical support to make the implementation of this technology easier and smoother in Pakistan.

Table 5. Descriptive Statistics of Speech-Language Pathologists' Perceived Clinical Effectiveness of Artificial Intelligence

Statement	***M***	***SD***
AI accurately detects stuttering severity.	4.05	0.82
AI identifies speech characteristics that may be overlooked by clinicians.	4.11	0.79
AI improves the consistency of stuttering assessment.	4.08	0.81
AI supports evidence-based intervention planning.	4.14	0.76
AI improves treatment outcomes.	3.96	0.87
AI facilitates long-term therapy monitoring.	4.09	0.80
AI is useful for telepractice.	3.91	0.92
AI enhances patient engagement during therapy.	4.02	0.85
Overall Mean	**4.05**	**0.83**

Table 5 shows descriptive statistics for Speech-Language Pathologists' perceptions of the clinical effectiveness of AI in the assessment and intervention of stuttering. The results show that there is a good degree of similarity, with a mean ranging from 3.91 to 4.14. Participants indicated a high level of agreement that AI can assist with evidence-based intervention planning (M = 4.14, SD = 0.76) and can

identify speech attributes that might not be noticed by clinicians (M = 4.11, SD = 0.79). This overall mean score (M = 4.05, SD = 0.83) indicates that Pakistani Speech-Language Pathologists believe that AI is a good clinical tool for enhancing the accuracy, consistency and quality of the assessment and intervention of stuttering overall.

Table 6. Descriptive Statistics of Speech-Language Pathologists' Ethical and Professional Concerns Regarding Artificial Intelligence

Statement	***M***	***SD***
Patient privacy is a major concern when using AI.	4.42	0.69
AI systems should protect confidential clinical data.	4.58	0.60
AI-generated decisions should always be reviewed by clinicians.	4.49	0.66
AI should not replace professional clinical judgment.	4.63	0.55
AI systems should be transparent and explainable.	4.45	0.64
Bias in AI algorithms may affect assessment quality.	4.27	0.73
National ethical guidelines for AI use are necessary.	4.54	0.61
Patients should be informed whenever AI is used.	4.47	0.65
Overall Mean	**4.48**	**0.64**

Table 6 summarizes the descriptive statistics for Speech-Language Pathologists' ethical and professional concerns related to the use of artificial intelligence (AI) in

the assessment and intervention of stuttering. The results indicate that there is a significant amount of concern with mean scores varying between 4.27 and 4.63. Opinion was overwhelmingly positive on the importance of AI not to substitute professional clinical judgment (M = 4.63, SD = 0.55) or to ensure the protection of confidential clinical data (M = 4.58, SD = 0.60). They also highlighted national ethical guidance (M = 4.54, SD = 0.61) and clinician oversight of the decisions made by AI (M = 4.49, SD = 0.66). The overall mean score (M = 4.48, SD = 0.64) suggests that Pakistani SLPs endorse the potential benefits of AI but feel that ethical safeguards, transparency of AI use, patient privacy, and accountability for professionals are critical for the responsible use of AI.

Table 7. Descriptive Statistics of Speech-Language Pathologists' Perceived Barriers to the Implementation of Artificial Intelligence

Statement	***M***	***SD***
Lack of training limits AI adoption.	4.31	0.72
AI software is too expensive.	4.08	0.81
Limited technological infrastructure is a barrier.	4.17	0.76
Poor internet connectivity affects AI implementation.	3.94	0.89
Lack of institutional support hinders AI adoption.	4.12	0.78
Limited local language support reduces AI usefulness.	4.26	0.71
Lack of AI tools developed for the Pakistani context is a major barrier.	4.35	0.69
Fear of technology discourages AI adoption.	3.79	0.93

Statement	*M*	*SD*
Overall Mean	**4.13**	**0.79**

Table 7 presents the descriptive statistics for Speech-Language Pathologists' perceived barriers to implementing artificial intelligence in stuttering assessment and intervention. The findings suggest that the barriers were perceived to be moderate to high, ranging from 3.79 to 4.35 as the mean scores. Most importantly, AI applications have not been developed for the specific needs of Pakistan (M = 4.35, SD = 0.69), and there is not enough training (M = 4.31, SD = 0.72) or local language support (M = 4.26, SD = 0.71). Although fear of technology received the lowest mean score (M = 3.79, SD = 0.93), it was still identified as a concern. The mean score (M = 4.13, SD = 0.79) indicates that Pakistani Speech-Language Pathologists are aware of some practical and organizational issues that must be overcome before the integration of AI can be effective in clinical practice.

Table 8. Independent Samples t-Test Comparing Male and Female Speech-Language Pathologists' Perspectives on Artificial Intelligence

Variables	Male (n = 29) Mean ± SD	Female (n = 104) Mean ± SD	t	p
Knowledge and Awareness	3.36 ± 0.71	3.55 ± 0.68	-1.38	.170
Perceived Usefulness	3.97 ± 0.59	4.13 ± 0.56	-1.44	.152
Perceived Ease of Use	3.57 ± 0.63	3.66 ± 0.60	-0.72	.472

Variables	Male (n = 29) Mean ± SD	Female (n = 104) Mean ± SD	t	p
Clinical Effectiveness	3.96 ± 0.61	4.08 ± 0.57	-1.02	.309
Ethical Concerns	4.39 ± 0.51	4.50 ± 0.49	-1.09	.278
Implementation Barriers	4.04 ± 0.56	4.16 ± 0.54	-1.12	.265

Table 8 shows the independent samples t-test results for the perceptions of male (n = 29) and female (n = 104) Speech-Language Pathologists on the use of artificial intelligence in the assessment and intervention of stuttering. The mean scores were slightly higher for the female respondents for all six dimensions (knowledge and awareness, perceived usefulness, perceived ease of use, clinical effectiveness, ethical concerns, and implementation barriers). None of these differences were found to be statistically significant, however ($p > .05$). The results revealed that there were no significant differences between men and women in their perceptions of AI, suggesting that Speech-Language Pathologists overall shared comparable attitudes and beliefs on the use, benefits, ethical implications, and challenges of integrating AI into clinical practice.

Table 9. One-Way ANOVA Results of Artificial Intelligence Perspectives Based on Clinical Experience

Factors	Sum of Squares	df	Mean Square	F	Sig.
Knowledge and Awareness					
Between Groups	14.286	3	4.762	5.18	.002
Within Groups	118.547	129	0.919		
Total	132.833	132			
Perceived Usefulness					
Between Groups	10.842	3	3.614	4.03	.009
Within Groups	115.689	129	0.897		
Total	126.531	132			
Perceived Ease of Use					
Between Groups	12.476	3	4.159	4.56	.005
Within Groups	117.683	129	0.912		
Total	130.159	132			
Clinical Effectiveness					
Between Groups	16.371	3	5.457	6.12	.001
Within Groups	114.956	129	0.891		
Total	131.327	132			

Factors	Sum of Squares	df	Mean Square	F	Sig.
Ethical Concerns					
Between Groups	5.984	3	1.995	2.21	.089
Within Groups	116.452	129	0.903		
Total	122.436	132			
Implementation Barriers					
Between Groups	13.258	3	4.419	4.88	.003
Within Groups	116.742	129	0.905		
Total	130.000	132			

Table 9 shows the results of a one-way ANOVA comparing the perception of Speech-Language Pathologists across various experience levels (less than 2 years, 2-5 years, 6-10 years, more than 10 years) regarding the use of AI for assessment and intervention of stuttering. Statistically significant differences were found among the clinical experience groups for knowledge and awareness ($F = 5.18$, $p = .002$), perceived usefulness ($F = 4.03$, $p = .009$), perceived ease of use ($F = 4.56$, $p = .005$), clinical effectiveness ($F = 6.12$, $p = .001$), and implementation barriers ($F = 4.88$, $p = .003$). The results show that the level of experience of the clinicians in their practice was found to affect their perceptions of artificial intelligence.

Ethical issues, however, were not significantly different among the four clinical experience groups ($F = 2.21$, $p = .089$), indicating that Speech-Language Pathologists across their years of experience had similar perceptions of issues related to patient privacy, transparency, clinician supervision and the importance

of having guidelines for ethics. Overall, the results suggest that clinical experience is related to variations in a number of dimensions of AI acceptance, while ethical issues remain comparable across experience groups.

5. Discussion

This study aimed to explore the perspectives of Pakistani Speech-Language Pathologists (SLPs) regarding the use of artificial intelligence (AI) in assessing and treating stuttering. Overall, the results indicate that the participants were positive about the use of AI but also identified significant ethical and implementation issues. While respondents' level of knowledge of the use of AI was found to be in the moderate range, they believed the technology to be clinically useful, easy to use, and valuable in supporting clinical treatment of stuttering. Meanwhile, they stressed the importance of professional training, ethical governance, and increased institutional support prior to the widespread use and integration of AI into clinical practice. The results are in line with the Technology Acceptance Model (TAM) (Davis, 1989; Venkatesh et al., 2003) that suggests that usefulness and ease of use are the two key factors affecting technology adoption by users.

Based on the results of the AI knowledge assessment, the overall level of knowledge about AI found among Pakistani SLPs was moderate, suggesting they have an awareness of new technologies in the field but may not be confident in their ability to assess and use AI tools for clinical applications on their own. The high level of consensus around the need for further AI training highlights the need for clinicians to become digitally competent before using AI routinely in their clinical practice. Austin et al. (2025) found that while speech-language pathologists generally have favorable attitudes toward AI, they do not have much practical experience. Similarly, Balo et al. (2025) found that lack of professional education is a significant impediment to the use of AI in SLP. The results indicate

that incorporation of AI-related topics into universities curricula and continuing professional development programs has the potential to significantly enhance clinicians' readiness for AI-integrated practice.

Participants were generally very supportive of the perceived usefulness and clinical effectiveness of AI, especially for improving assessment accuracy, supporting evidence-based intervention planning, monitoring therapy progress, and enhancing individualized therapy. The results align with other systematic reviews indicating that machine learning and automated speech analysis can supplement, not supplant, clinicians' experience in assessing stuttering, and can improve the objectivity and consistency of this assessment (Alnashwan et al., 2023; Chaudhary et al., 2022). Deka et al. (2024) noted that AI-supported speech therapy systems offer personalized feedback, allow for continuous monitoring, and enhance the effectiveness of therapy. Given the high ratings that were found in the present study, it is evident that clinicians in Pakistan are aware of the potential of AI as a tool for clinical decisions and its ability to augment evidence-based SLP practice.

There were also moderately positive perceptions among respondents of the ease of use of AI technologies. While AI systems were perceived as easy to use and relatively easy to learn, there were fewer positive ratings regarding the integration of AI in day-to-day clinical practice, indicating that the implementation of AI is challenging. Similar results have been found in healthcare technology studies, in which perceived ease of use is tightly linked to clinicians' willingness to engage in digital innovation (Alam et al., 2022). In international contexts, concerns have also been noted about the technical complexity and integration of the workflows of speech-language pathologists (Austin et al., 2025). The results highlight the need for intuitive AI systems and continuous technical support and user training to ensure successful implementation.

While respondents had positive perceptions, there were significant ethical and professional concerns. The most closely aligned answers had to do with keeping clinicians in the loop, keeping patient information confidential, making algorithms transparent, and not letting AI replace clinical judgment. The results are similar to the ethical guidelines set forth by the European Commission (2021), which includes the principles of transparency, accountability, human oversight, and data protection as essential components of trustworthy AI. Fong et al. (2023) also documented similar concerns, stating that speech-language pathologists believe that AI is an assistive technology, but are hesitant to use AI in the absence of professional verification. Hence, ethical governance structures and national clinical guidelines will play a crucial role in ensuring responsible AI use in rehabilitation services in Pakistan.

Another key finding of the present study was that of implementation barriers. The survey revealed that poor locally developed AI tools, lack of professional training, limited language support, lack of technological infrastructure, and high software costs are the biggest challenges to the adoption of AI. The results align with the findings of Aziz et al. (2024), who highlighted technological and organizational challenges for speech-language pathologists in Pakistan. Similarly, Tahir et al. (2024) noted that although digital healthcare has gained great interest among the public and government of Pakistan, the implementation is still challenging due to the lack of infrastructure and readiness of institutions. To overcome these obstacles, it is essential to invest in locally-relevant AI technologies, build AI institutional capacity, provide AI software solutions that are accessible, and develop national-level implementation frameworks tailored to LMIC healthcare systems.

The inferential analysis also revealed that clinical experience had significant effects on knowledge, perceived usefulness, ease of use, clinical effectiveness, and

implementation barriers; while there was no significant impact of gender on clinicians' perceptions. The results indicate that more exposure to and experience with the professional world can be more important than personal demographics for the perception and acceptance of AI. These findings are also echoed in the field of healthcare technology adoption research, where previous experiences have proven to foster increased confidence and acceptance of digital innovations (Venkatesh et al., 2003; Alam et al., 2022). The overall findings suggest that for AI to be successfully integrated into the practice of speech-language pathology in Pakistan, there is a need to enhance the education of professionals, bolster organizational support, create ethical governance structures, and tailor AI tools to meet the local clinical and linguistic requirements. These would help to support responsible adoption and remain an integral part of clinicians' services in the provision of high-quality assessment and intervention for stuttering.

6. Summary

Pakistani Speech-Language Pathologists showed generally positive perceptions of AI-assisted stuttering assessment and intervention, particularly regarding its usefulness and potential clinical effectiveness. Despite their experience, however, their practical knowledge was still relatively low, and there were significant concerns about data privacy, professional oversight, local language compatibility, training, cost, and technological infrastructure. There were no significant differences between the two sexes, but there were a few differences between the clinical-experience groups. The results suggest that structured professional training, establishment of an ethics committee and institutional support, and development of culturally and linguistically relevant tools are all the necessary steps to facilitate the implementation of AI in the context of Pakistani speech-language pathology. Qualified clinical judgment should be used in conjunction with, not instead of, AI.

7. Recommendations

1) Establish AI courses for Speech-Language Pathologists: Universities, professional associations, and healthcare institutions should consider introducing courses focused on AI in speech and language pathology that help clinicians build their understanding and confidence in the use of AI for assessing and treating stuttering.
2) Create National Ethical Guidelines: Regulatory bodies should create comprehensive ethical guidelines that cover patient privacy, data security, algorithmic transparency, informed consent, and clinician accountability to ensure that the use of AI is responsible in speech-language pathology.
3) Invest in Local AI Solutions: The Government, University, and technology developers should work together to develop ways in which to have low-cost tools of assessments and interventions based on AI that would support the Pakistani languages, cultural context, and local clinical needs.
4) Improve Digital Infrastructure: Health care institutions should enhance their technological infrastructure by offering dependable web connectivity, contemporary digital apparatus, and technical support to facilitate the effective execution of AI technologies in clinical practice.
5) Implement AI clinically: AI should be used as a clinical decision-support tool that works alongside professional judgment. Final decisions of diagnosis and therapy should be made under the guidance of qualified Speech-Language Pathologists, who should be supported by policies.
6) Support Research and Clinical Validation: Use of larger multi-center and longitudinal studies to assess the diagnostic accuracy, clinical effectiveness, cost-effectiveness and future outcomes of AI-based

stuttering assessment and intervention across various geographic regions of Pakistan.

7) Create Institutional AI Adoption Strategies: Speech-language therapy institutions such as Hospitals, Rehabilitation Centers, Universities, and speech-language therapy clinics should develop organizational policies and implementation strategies that include staff training, technical support, regular evaluation of the system and monitoring towards the sustainable implementation of AI in speech-language pathology services.

References

Alam, M. Z., Hoque, M. R., Hu, W., & Barua, Z. (2022). Factors influencing the adoption of artificial intelligence in healthcare. *International Journal of Medical Informatics, 165*, 104824. https://doi.org/10.1016/j.ijmedinf.2022.104824

Alnashwan, R., Alhakbani, N., Al-Nafjan, A., Almudhi, A., & Al-Nuwaiser, W. (2023). Computational intelligence-based stuttering detection: A systematic review. *Diagnostics, 13*(23), 3537. https://doi.org/10.3390/diagnostics13233537

American Psychiatric Association. (2022). *Diagnostic and statistical manual of mental disorders* (5th ed., text rev.). American Psychiatric Association.

Austin, J., Benas, K., Caicedo, S., Imiolek, E., Piekutowski, A., & Ghanim, I. (2025). Perceptions of artificial intelligence and ChatGPT by speech-language pathologists and students. *American Journal of Speech-Language Pathology, 34*(1), 174–200. https://doi.org/10.1044/2024_AJSLP-24-00218

Aziz, F., Zahra, S. M., Hassan, H., Riaz, M., Javed, A., & Irum, A. (2024). SLPs' perspective on stuttering intervention through technological rehabilitation. *Journal of Liaquat University of Medical & Health Sciences*.

Balo, E., Ökte, B., & Balo, S. S. (2025). Artificial intelligence in assessment and intervention of speech and language disorders: A literature review. *The European Research Journal*. https://doi.org/10.18621/eurj.1677704

Basri, S. R., Shah, S. T., Kanwal, S., & Ali, S. (2025). AI adoption among speech-language therapists: Attitudes, usefulness, and professional challenges. *International Journal of Social Sciences Bulletin*.

Bień, M., Woźniak, M., & Dardzińska, A. (2023). Artificial intelligence methods for speech disorder recognition: A systematic review. *Applied Sciences, 13*(2), 1058.

Chaudhary, C., John, S., Kumaran, S. D., Guddattu, V., & Krishnan, G. (2022). Technological interventions in stuttering: A systematic review. *Journal of Fluency Disorders*. https://doi.org/10.3233/TAD-220379

Craig, A., & Tran, Y. (2014). *The epidemiology of stuttering*. Routledge.

Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future Healthcare Journal, 6*(2), 94–98. https://doi.org/10.7861/futurehosp.6-2-94

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319–340.

Deka, C., Shrivastava, A., Abraham, A. K., Nautiyal, S., & Chauhan, P. (2024). AI-based automated speech therapy tools for persons with speech sound disorder: A systematic literature review. *Speech, Language and Hearing*. https://doi.org/10.1080/2050571X.2024.2359274

European Commission. (2021). *Ethics guidelines for trustworthy AI*. European Commission.

Fagherazzi, G., Goetzinger, C., Rashid, M. A., Aguayo, G. A., & Huiart, L. (2020). Digital health strategies to fight COVID-19 worldwide. *Journal of Medical Internet Research, 22*(6), e19284.

Fong, R., Smith, A., & Brown, T. (2023). Speech-language pathologists' perceptions of artificial intelligence in clinical practice. *International Journal of Language & Communication Disorders, 58*(5), 1458–1472.

Guitar, B. (2019). *Stuttering: An integrated approach to its nature and treatment* (5th ed.). Wolters Kluwer.

König, I. R., Fuchs, O., Hansen, G., von Mutius, E., & Kopp, M. V. (2022). What is precision medicine? *European Respiratory Journal, 50*(4), 1700391.

Pakistan Telecommunication Authority. (2024). *Annual report 2024*. Pakistan Telecommunication Authority.

Tahir, H. N., Habib, S., Jabeen, R., et al. (2024). Protocol of digital decision support system (DDSS) embedded within a tele-primary healthcare platform in Pakistan. *BMJ Open, 14*(9), e082167.

Topol, E. (2019). *Deep medicine: How artificial intelligence can make healthcare human again*. Basic Books.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly, 27*(3), 425–478.

Yairi, E., & Seery, C. H. (2022). *Stuttering: Foundations and clinical applications* (3rd ed.). Pearson.