



AI LITERACY COMPETENCIES AMONG LIBRARY PROFESSIONALS IN SAUDI ARABIA: A COGNITIVE, NORMATIVE, AND BEHAVIOURAL PERSPECTIVE

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Abstract

The aim of the study was to explore the artificial intelligence (AI) competencies (cognitive, behavioural, and normative) that library professionals need to acquire; the AI ethical issues associated with AI literacy and essential knowledge areas; and differences in participants' opinions across demographic variables. A quantitative study based on a self-developed questionnaire. The data were collected from library professionals in Saudi Arabia via Google Forms. There were 103 replies, of which 96 were valid. Saudi Arabian librarians demonstrated moderate to low AI literacy across cognitive, behavioural, and normative competencies, with mean scores ranging from 2.07 to 3.05 on a 5-point scale. They were aware of AI tools that might improve library operations, but they did not purchase or integrate them. There was also a lack of ethical awareness, as professionals have just now struggled to determine if AI is trustworthy and what privacy concerns need to be addressed. Some found the AI training program they attended inadequate, suggesting that it may be necessary to schedule tailored training. Inferential analysis showed no significant differences in AI literacy across the demographic variables. This study is unique; no studies have examined AI literacy skills among library professionals in Saudi Arabia. This study will provide input to the literature on librarianship, the social sciences, and AI literacy. This study had a limited population of library professionals in Saudi Arabia through random and convenient availability.

Keywords: AI Literacy; AI-Powered Librarian, Artificial Intelligence; AI information Professionals; AI Competencies, AI trainings, Saudi Arabian Librarians

1. Introduction

Artificial Intelligence (AI) has created massive disruption in almost all sectors and has transformed a range of operations and services. Libraries are transforming and gearing up to harness the power of AI to enhance the efficiency, accessibility, and personalization of library services, thereby reshaping the traditional library landscape. The transformation has been observed in several of the traditional library services as AI is automating routine tasks such as cataloguing and classification of the collections, enhancing search functionalities and information retrieval, thereby creating a much more accurate and organized library system while librarians have more time to focus more on intellectual stimulating activities (Preethi, 2024; Ram, 2024). AI creates a personalized user experience as machine learning algorithms can analyse the user information seeking behaviour and based on that provides personalized recommendations which in turn provide enhance user engagement and satisfaction (Amalia et al, 2024; Sardar & Khan, 2026).

AI in libraries can improve service delivery through advanced data analytics by understanding and responding to user needs in real time (Okwu et al, 2024). One of the key applications of AI technologies is providing AI powered assistive technologies such as translation services, text to speech and navigation



systems which can significantly enhance accessibility to people of determination and disabilities. Virtual assistants such as chat bot utilizing natural language processing are assisting patrons in navigating library systems and answering queries (Chauhan, 2024; Khan & Ullah, 2025). All these transformations will ultimately lead to evolving roles and skills of library and information professionals, and they need to become proficient and adept at using AI tools and technologies. Promoting AI literacy will be integral to professional development of library professionals as they will be taking task of ensuring ethical use of AI, data privacy, aligning AI tools and applications with library values of inclusivity and accessibility (Masrek & Khan, 2025; Okwu et al, 2024; Tzanova, 2024).

Despite the growing body of literature on AI literacy in libraries, most studies have focused on Western contexts, leaving a significant gap in understanding the preparedness of library professionals in the Middle East, particularly in Saudi Arabia. Recent research has primarily focused on integration of AI literacy into Library & Information Science (LIS) curriculum and coming up with the best practices in curriculum development. It is also important that while proposing a framework for AI literacy courses in academic libraires there needs to a collaboration among library professionals, students, faculty and ICT staff; as it will address constraints and promote safe AI practices (Chigwada, 2024; Khan & Lokman, 2026; Kizhakkethil & Perryman, 2024). Lo (2024) emphasized on hands on training and reskilling programs while, Scotti & Beltran (2024) advocated for workshops like “Phyton for all” for library professionals.

Deshen & Aharony (2024) suggested for promoting AI acceptance and usage among the library professionals while Sen (2024) advised integration of AI tools like ChatGPT and other in library services. Various other studies such as Garnier et al (2024) points towards addressing ethical and societal implications and concerns to develop AI literacy among library professionals, while Kautonnen & Gasparine (2024) advocated for B-wheel model which is inspired by design thinking and has the capabilities to build AI competencies among library and information professionals in academic libraires. There are few barriers and challenges of implementation of these strategies which includes resistance to change, budgetary constraints and the need for enhanced expertise to ensure successful integration of AI literacy programs in library settings. At the same time, it is important that libraries keep on fostering trust and address concerns to its patrons about AI and offer transparent ethical AI practices in library services.

1.1 Problem statement

As AI becomes increasingly integrated into library services, it is essential for library professionals to possess the skills necessary to navigate the evolving digital landscape. AI literacy is vital for enhancing service delivery, improving user engagement, and addressing ethical considerations. However, there is an urgent need to develop professional competencies through a multi-faceted approach, which includes curriculum enhancement, continuous learning, and hands-on training.

To address this gap, the present study assesses current AI literacy levels among library professionals in Saudi Arabia by examining their cognitive understanding of AI concepts, behavioral application of AI tools, and normative awareness of ethical and privacy issues related to AI use in library services. The findings will provide valuable insights to inform the development of AI-focused educational programs and training initiatives in Library and Information Science (LIS), ensuring that professionals are well-prepared for the future of library services.

1.2 Objectives of Research

The objectives of this study were to;

1. To assess the level of AI knowledge, awareness, and understanding among information professionals.
2. To evaluate the practical skills and usage of AI tools among information professionals.
3. To investigate the role of ethical awareness, trust, and perceived risk in AI adoption.
4. To examine how normative factors influence attitudes and behavioural intention toward AI.
5. To analyse the combined effect of cognitive, behavioural, and normative competencies on AI adoption.

1.3 Research Questions

RQ1. What is the level of AI literacy among information professionals?

RQ2. How do cognitive competencies influence attitudes toward AI?

RQ3. How do behavioural competencies affect AI usage and intention?



RQ4. What role do trust, ethics, and perceived risk play in AI adoption?

RQ5. How do the three dimensions collectively influence AI adoption?

2. Literature Review

2.1 Defining AI Literacy and Its Core Components

Artificial intelligence (AI) has seen unprecedented growth in the last couple of years, with widespread integration and application in various sectors. The libraries have kept pace with this advancement; they have already integrated AI tools and technologies, creating an urgent need for the necessary AI literacy skills among library and information professionals. The professionals need to develop AI literacy skills and, at the same time, enhance their human skills such as critical thinking, empathy, ethical judgment, and creativity to develop a balance between them. AI literacy can be defined as the ability to understand, engage, and critically evaluate AI related tools and technologies. It encompasses a wide range of competencies to navigate and interact with various AI tools and systems effectively and responsibly (Almatrafi et al., 2024; Yuan et al., 2024; Zhang, 2024). The key components of AI literacy are cognitive competencies, behavioral competencies, and normative competencies. The cognitive competencies include understanding of AI features and processing and algorithm influences (Almatrafi et al., 2024; Yuan et al., 2024). The behavioral competencies correspond to user efficacy (Yuan et al., 2024) and application and creation (Almatrafi et al., 2024). The normative competencies comprise of ethical considerations and threat appraisal influences (Almatrafi et al., 2024; Yuan et al., 2024).

2.2 Cognitive Competencies: Understanding AI Concepts and Technologies

One of the key components of LIS curriculum update is the technical understanding of AI and it is based on foundational knowledge and practical experiences. Lee and Cho (2024) argued that information professionals need to have a deep understanding of AI systems and tools which includes algorithms, machine learning principles and data processing. This will allow them to have a comprehensive understanding of functionality of AI technologies and their potential applications. Furthermore Erkunt (2023) argued that practical experience of working on these technologies can enhance their learning in a project-based settings. Another key component of AI literacy is ethical considerations, and information professionals need to understand the ethical issues related to AI such as biasedness, accountability, and privacy issues. It is important that information professionals know how to use AI responsibly and the challenges associated with it (Tadimalla & Maher, 2024). Varadarajan (2024) pointed that LIS curriculum also needs to address the broader socio-technical implications of AI that includes its impact on society and future trends.

The key AI technologies and concepts which should be a part of the LIS curriculum includes generative AI tools, machine learning and data analytics, and AI literacy and algorithms. The curriculum should include the most popular AI tools such as ChatGPT, Gemini, Bard among others which are impacting metadata, cataloging, and information retrieval in libraries. Having hands-on experience on these tools will equip the learners to use them for creating bibliographic records and enhancing library services (Snow et al., 2024; Torres, 2024). Machine learning technologies and data analytics are used for important tasks such as classification of resources, clustering, visualization of data etc. acquiring these skills will provide a competitive advantage in managing big data and improving the overall library operations and services (Luca et al., 2022). It is also crucial to have a foundational understanding of AI literacy which includes algorithm, data processing and machine learning that will help in critically evaluating AI tools and technologies and their applications (Erkunt, 2023; Tadimalla & Maher, 2024). Information professionals need to have practical applications and incorporating practical exercises such as creating MARC/RDA bibliographic records with AI tools can provide them with much needed hands-on experience (Snow et al., 2024). AI powered tools can also be used for designing of curriculum by aligning educational content with industry trends and staff requirements (Saddam & Hasan, 2024).

2.3 Behavioural Competencies: Practical Application and Integration of AI Tools

It is crucial for information professionals to understand and get familiarized with AI concepts such as generative AI, machine learning and natural language processing to take informed decisions about AI tool integration with various library services and operations (Pickett & Pennington, 2024). In terms of technical skills knowledge such as programming, data management and AI tool usage has also become essential to work with AI driven technologies to perform tasks like information retrieval and data analysis (Babashahi et al.,



2024; Khan et al., 2025; Murari et al., 2024). Adaptability and problem-solving skills are also much needed for information professionals so that they can keep pace with evolving AI technologies, and they need to be flexible and open to lifelong learning.

AI tools have the capabilities to enhance problem-solving skills as they can provide data driven insights and information professionals should develop skills to interpret AI generated data, visualize and apply it to solve complex problems (Babashahi et al., 2024; Priya, 2024). One of the key skills information professionals should possess is their ability to communicate effectively as this is vital for explaining AI process and outcome to inexperienced users. The ability to convey complex technical information in an accessible manner will create rapid awareness related to AI literacy among users (Zhang, 2024). Collaborative skills among information professionals requires them to work in tandem with AI and humans and this machine human-interaction can foster teamwork especially in AI driven projects (Du, 2024). Evaluation and critical thinking skills is the key component of AI literacy and information professionals should be well equipped and trained to critically assess AI tools and technologies while identifying their key strengths and limitations (Hollands & Breazeal, 2024). AI literacy also involves problem-solving skills as it assists information professionals to identify the challenges posed by AI technologies and finding innovative solutions within their work environment (Allen & Kendeou, 2023).

2.4 Normative Competencies: Ethical Awareness, Trust, and Responsible AI Use

One of the key challenges associated with AI is ethics and it is of paramount importance that information professionals should have higher understanding of the ethical implications of AI and address these challenges which are just not limited to data privacy, hallucinations, biasedness and unreliable and misinformation (Bhowmich et al., 2024). AI is going to transform business and organizational roles; and information professionals will accept leadership roles and managerial responsibilities such as managing a large team and overseeing AI initiatives and projects (Luca et al., 2022). Information professionals need to work on their personalized learning and digital literacy with a growth mindset and AI tools can facilitate personalized and adaptive learning. AI tools have the capabilities to tailored educational content and programs as per the individual needs and it is important that with enhance digital literacy, information professionals can promote access to AI resources and training as well as empower divers communities (Parra-Valencia & Massey, 2023). Information professionals need to collaborate with educators to create a comprehensive AI literacy module which is interdisciplinary in approach and ensures that students are professionals have the necessary skills and knowledge to thrive in an AI driven environment. There is a need for continuous professional development to keep at par with the rapid development in AI technologies and keeping abreast with new AI tools and their potential applications (Merceron & Best, 2024).

The skills library professionals need to develop to navigate the evolving landscape of AI effectively include the key elements such as technical proficiency, ethical reasoning and responsible use, human-AI collaboration, lifelong learning and adaptations, information literacy integration, data literacy, AI algorithm literacy and digital literacy and misinformation. Technical proficiency involves understanding of AI concepts such as machine learning, natural language processing (NLP), data mining and familiarity with AI tools and applications such as data analysis, content creation and information retrieval (Andersdotter, 2023; Houston & Corrado, 2023). Information professionals need to have the necessary skills of ethical reasoning and responsible use which involves ethical considerations such as awareness about ethical implications of AI and issues related to privacy, biasedness and job displacement (Yanyi, 2024) and at the same time critical evaluation skills is required for evaluating AI technologies for responsible use (Tenório, 2023; Hossain, 2024). Human-AI collaboration is critical to success of AI implementation and integration as information professionals need to develop collaboration skills to collaborate with various AI systems and understanding their limitations and strength to enhance human capabilities. It is also important to understand that human centric AI values are maintained to ensure AI tools and applications serve to augment human decision making rather than to replace it (Yanyi, 2024).

2.5 AI Literacy Training, Curriculum Integration, and Implementation Challenges

The integration of AI literacy into the Library & Information Science (LIS) curriculum is the first step towards preparation of future librarians. Most of the efforts now is concentrated on identifying competencies



which are affected by AI but there needs to be a long terms plan in the form of structured curriculum development in LIS to address these disruptive technologies (Kizhakkethil & Perryman, 2024). Chigwada (2024) argued that a framework for digital literacy courses in higher education libraries need to be proposed in collaboration with librarians, Faculty members and ICT personnel to develop AI literacy courses for information professionals. Dshen and Aharony (2024) identified several factors related to librarians' acceptance of AI technology which included social factors, positive emotions towards AI and hedonic motivation that correlated with higher AI literacy which can influence AI literacy among librarians. Lo (2024) found out that GPT-4 exploration program was highly effective in fostering a culture of innovation and practical experience with AI tools and technologies; such program is important for effective AI reskilling. Sen (2024) highlights that integration of AI tools such as ChatGPT in library services can enhance promotional activities, saves times, increase service uptake and can allow librarians to focus more on other critical services. Kautonen & Gasparini (2024) found that the B-Wheel model based on design thinking has the potential to offer a comprehensive approach to building AI competencies among academic libraries as it emphasizes learning by doing and avoiding partial optimization of AI skills. The complexities within AI technologies poses challenges in ensuring widespread adoption of AI literacy among librarians as it is important to avoid negative impacts on inclusion, equality, and diversity within the library profession. Molopa et al. (2024) highlighted that AI has the potential to transform information access, processing, and retrieval in a big way; re-evaluation of information literacy programs and the role of librarians to ensure that they learn new skills in response to new learning settings and AI tools and technologies and the information literacy programs are suitable for new learnings and cover all aspects of AI literacy.

It is important to promote awareness about AI's influence on various sectors and industries and possible societal changes it can cause. Allen and Kendeou (2023) highlighted the need for integration of AI literacy across different disciplines as it will enhance collaborations between different subject areas and encourage information professionals to apply AI in diverse context. Information professionals should not fear experimenting with AI tools and discovering ways to enhance library services and other information related services. Integrating AI literacy into existing media and information literacy programs is a feasible approach as it will involve updating the curriculum with topics such as data literacy, generative AI, AI algorithm, AI ethics and understanding the limitation of AI technologies (Ndungu, 2024). Ko and Chiu (2024) suggested that ACRL "Framework for Information Literacy for Higher Education" can be considered as a foundation for AI literacy and information and media literacy professionals can develop instructional materials and guides which can include AI literacy components. The nature of AI is such that it is always evolving at a rapid pace and to cope up with these technologies; curriculum needs to emphasize on continuous learning and adaptability and promote a culture of lifelong learning. Information professionals need to always keep on learning and stay updated with the latest developments in AI and best practices (Breazeal et al., 2023; Kizhakkethil & Perryman, 2024). The curriculum needs to be designed with a modular and flexible approach which will allow for adapted learning in different contexts and level and can always stay relevant and accessible to wide range of learners (Breazeal et al., 2023). Competency frameworks can be useful in competency development and assessment of the LIS curriculum. UNESCO's AI competency frameworks can guide in the development of AI literacy through structured pathways for learning and assessment (Faruqe et al., 2021; Mutawa & Shruthi, 2025). Evaluation and feedback mechanisms needs to be incorporated to measure the effectiveness of the AI literacy program and to ensure that learners are acquiring the necessary AI skills and competencies (Allen & Kendeou, 2023; Holland & Breazeal, 2024).

Information professionals need to enhance and continue their professional development journey by undergoing new AI related courses, training, workshops, and participation in various AI related projects (Kautonen & Gasparini, 2024). Another way of continuous learning involves participating in learning circles where information professionals can discuss and collaborate on AI related content and its application and integration in library services. This will foster a learning environment and build confidence among the library professionals (Andersdotter, 2023). Library and information professionals are exploring various AI powered tool to upscale and enhance their services in information retrieval, personalized and adaptive learning experiences, and tailored recommendations (Bhuvaneshwari & Rajakumar, 2024; Molopa et al., 2024).



Libraries are engaged in developing activities that leverages experiential learning which can assist information professionals understand the capabilities and limitations of various AI tools such as ChatGPT (Johnson et al., 2024). Libraries are facing challenges in terms of budget constrain in investing in information technology infrastructure to support AI applications and its integration into library services (Chatikobo & Pasipamire, 2024). Another key challenge is addressing ethical and legal issues associated with AI in terms of data protection and privacy, transparency and biasedness while implementing AI in libraries.

Library professional need to have proper understanding about these issues and equipped themselves to navigate these issues in a responsible manner (Miltenoff, 2024; Subaveerapandiyan & Gozali, 2024). It is imperative to provide professionals with continuous training and clear communication about the benefits of AI integration can assist in mitigating this resistance to change. In academic environment, there needs to interdisciplinary collaboration between the library professionals, educators, and other stakeholders for developing a comprehensive AI literacy program (Merceron & Best, 2024). Lo (2024) identified that academic library professionals in United States have modest self-rated understanding of AI concepts and has very little hand on experience with AI tools and had notable gaps in knowledge related to ethical implication and collaborative AI practices. Miltenoff (2024) advocated the need for comprehensive need of training and ethical guidelines for library and information professional to adapt to AI literacy despite having expertise in delivering information and media literacy sessions.

One of the key critical success factors is the skill to lifelong or continuous learning and adaptation and as such ongoing education in the form of professional development and updating the curriculum according to the AI advancement is necessary (Yani, 2024; Ndungu, 2024). Continuous learning also encompasses the ability or the skill to be adaptable and open to learning new AI related skills and integrate them in workflows, services, and operations (Andersdotter, 2023). Integration of AI information literacy (IL) into all existing IL programs will enhance students and user capabilities in searching, retrieving, evaluating, and using information effectively in an AI driven environment (Carroll & Borycz, 2024; Ndungu, 2024). The information literacy delivery professionals need to upscale themselves to teach AI literacy to users, making them understand and navigate AI tools and technologies (Andersdotter, 2023). Data literacy is a key skill which information professional needs to acquire to understand data management and big data technology awareness. This will enable them to manage and analyse large datasets, understanding of data security and ensuring the integrity of data used in AI (Jinghua, 2021; Daxing, 2021). Knowledge of AI algorithm literacy and algorithm transparency among information professionals is important as it enable them to know how AI algorithms work, identify potential biases and to interpret their outputs. Furthermore, advocating for algorithm transparency in AI algorithms ensures that they clear and accountable (Ndungu, 2024). The final key skill all information professionals needs to acquire is digital literacy and misinformation that will assist them in navigating misinformation such as deep fakes which are produced by AI tools. At the same time, it will ensure promotion of responsible digital citizenship and ethical use of AI technologies (Blankenship, 2021).

3. Research Methodology

3.1 Research Design

A quantitative research method was employed to assess the need to build AI literacy among library professionals in Saudi Arabia. A cross-sectional survey design was adopted to collect data at a single point in time, allowing for the measurement of current AI literacy levels across cognitive, behavioural, and normative dimensions.

3.2 Population and Sampling

The study primarily targeted a diverse sample of library professionals working in universities, colleges, schools, and public libraries across Saudi Arabia. A convenience sampling technique was used due to the absence of a comprehensive national directory of library professionals. The online survey was distributed using the researchers' professional contacts via WhatsApp, LinkedIn, and school library WhatsApp groups. Additionally, participants were requested to share the survey link within their professional networks (snowball sampling) to expedite the data collection process. A total of 103 responses were received, out of which 96 were deemed valid and complete for analysis. The sample size is considered adequate for statistical analysis given the exploratory nature of the study and the estimated population of library professionals in Saudi Arabia.



3.3 Survey Instrument

The survey instrument was self-developed based on the tripartite framework of AI literacy (cognitive, behavioural, and normative competencies) informed by the literature (Almatrafi et al., 2024; Yuan et al., 2024). The questionnaire consisted of three sections:

- Section A: Demographic Information – Collected data on age, gender, years of experience, educational level, and type of library.
- Section B: AI Literacy Competencies – Measured cognitive (5 items), behavioural (5 items), and normative (5 items) competencies using a 5-point Likert scale ranging from 1 = "Strongly Disagree" to 5 = "Strongly Agree."
- Section C: Training Effectiveness and Ethical Considerations – Included items on prior AI training, perceived effectiveness of training, and ethical challenges associated with AI use in libraries.

3.4 Ethical statement

All participants provided informed consent prior to completing the survey. The purpose of the study was clearly explained, and participation was entirely voluntary. Respondents were assured that their responses would remain anonymous and confidential, and no personally identifiable information was collected.

3.5 Instrument Validation

The survey instrument was pilot tested with 10 library professionals who were not included in the final sample. Based on the pilot feedback, minor wording adjustments were made to improve clarity and relevance. Internal consistency reliability was assessed using Cronbach's alpha, yielding acceptable values for the cognitive ($\alpha = 0.82$), behavioural ($\alpha = 0.79$), and normative ($\alpha = 0.81$) competency subscales, indicating good reliability.

3.6 Data Collection Procedure

The online survey was created using Google Forms, and a link was distributed through the researchers' professional networks. Two reminder messages were sent at one-week intervals to maximize response rates. All responses were automatically recorded in a secure spreadsheet and later exported to SPSS for analysis.

3.7 Data Analysis Plan

Data analysis was conducted using IBM SPSS Statistics 2023. The following statistical procedures were performed:

- Descriptive statistics (frequencies, percentages, means, and standard deviations) to summarize demographic characteristics and AI literacy levels.
- Independent samples t-test to compare AI literacy scores between male and female participants.
- One-way analysis of variance (ANOVA) to examine differences in AI literacy across age groups, experience levels, educational backgrounds, and library types.

Prior to conducting parametric tests, assumptions of normality (Shapiro-Wilk test) and homogeneity of variance (Levene's test) were checked. The significance level was set at $p < 0.05$ for all inferential tests. Effect sizes were planned to be reported for significant findings; however, no statistically significant differences were found.

4. Data Analysis

The data analysis was conducted using SPSS software, and various analysis was performed which included descriptive statistics to summarize demographic information and patterns of response, an independent sample T-test to compare variables between different groups, such as male vs female and an ANOVA test to analyse the difference in variables across various library types, educational levels, experience-based, and age groups.

For demographic variables, participants were asked about their age, education, experience, and type of library they work in. Table 1 elaborates that majority of library professionals belonged to age group 45-54, and possess work experience of 16 and more than 16 years. There were 54 male and 42 female library professionals who participated in the study. In the same way, a majority of professionals had a master's degree, and were working in university libraries.



Table 1
Demographics of Participants

	Age	Frequency	Percentage
Age	18-24	0	0.0
	25-34	10	10.4
	35-44	41	42.7
	45-54	33	34.4
	55 and above	12	12.5
Gender	Male	54	55.8
	Female	42	44.2
Experience in years	0-5	7	8.1
	6-10	8	9.3
	11-15	28	20.9
	16 and above	53	61.6
	Total	96	100.0
Education	Bachelors	19	22.1
	Masters	54	51.2
	PhDs	23	26.7

4.2 Current level of AI literacy (Cognitive competencies)

The results (Table 2) elaborate that the librarians possess limited AI literacy with reference to cognitive competencies. The majority of the participants (51.2%) were unable to explain basic principles of AI to others; only 24.4% were strongly agreed that they could explain AI principles to others (M=2.59, SD=1.74). Similarly, a significant portion (around 30%) reported being unable to differentiate various AI technologies, and only 30% agreed with their ability to differentiate these technologies (M=2.67, SD=1.55). The majority was not familiar with AI tools used in libraries (38.4%), and they do not possess the abilities to identify AI applications in the library services (39.5%), with a mean score of 2.85. Last but not least, understanding the limitations of AI had the highest level of disagreement, with 50% strongly disagreeing (M=2.48, SD=1.62). The overall mean score indicates that respondents possess an average level of AI literacy, suggesting a need for AI-focused training programs.

Table 2
AI Competencies Level (Cognitive competencies) (N=96)

Statement	SD	D	N	A	SA	Mean	SD
I can explain the basic principles of artificial intelligence to others.	54 (51.2%)	1 (1.2%)	8 (9.3%)	12 (14%)	21 (24.4%)	2.59	1.74
I understand differences between various AI technologies (e.g., machine learning, natural language processing, gen AI)	44 (39.5%)	3 (3.5%)	21 (24.4%)	13 (15.1%)	15 (17.4%)	2.67	1.55
I am familiar with popular AI tools used in library services (e.g., ChatGPT, Gemini etc.).	43 (38.4%)	2 (2.3%)	9 (10.5%)	12 (14%)	30 (34.9%)	3.05	1.77
I can identify potential applications of AI in library and information services.	44 (39.5%)	2 (2.3%)	15 (17.4%)	13 (15.1%)	22 (25.6%)	2.85	1.67
I understand the limitations of current AI technologies	53 (50%)	2 (2.3%)	13 (15.1%)	13 (15.1%)	15 (17.4%)	2.48	1.62

Note. SD = Strongly Disagree (1), D = Disagree (2), N = Neutral (3), A = Agree (4), SA = Strongly Agree (5). Mean scores below 3 indicate disagreement or low competency.



4.3 Current level of Behavioural Competencies

Secondly, behavioural competencies were measured to check the current level of AI literacy among library professionals. The results (Table 3) show that the majority of library professionals possess limited experience with using AI-based tools for completing their tasks. The majority of the participants (70%) disagreed that they have experience using AI tools for bibliographic records (M=2.23, SD=1.29). In terms of using AI-powered data analytics for library operations, 32.6% were strongly disagreed, and 18.6% were disagree, which confirms that they have limited practical application (M=2.52). The majority (50%) disagreed that they can use AI tools for information retrieval (M=2.57). In the same way, 50.1% showed reluctance or lack of familiarity with integrating AI tools into library services. The mean score below 3 indicates disagreement or lack of confidence among library professionals. Thus, the mean score given in Table 3 demonstrate low level of AI behavioural competencies among library professionals. Standard deviations indicate some variation, but overall responses suggest that most professionals are not yet actively engaged in AI-driven library practices. Overall, professionals had less experience with AI tools with specific integration into library services, such as data analytics or information retrieval.

Table 3

Current level of AI literacy (Behavioural competencies) (N=96)

Statement	SD	D	N	A	SA	Mean	SD
I have experience using AI tools for creating bibliographic records.	45 (40.7%)	18 (20.9%)	17 (19.8%)	10 (11.6%)	6 (7%)	2.23	1.29
I can use AI powered data analytics tools to improve library operations.	38 (32.6%)	16 (18.6%)	19 (22.1%)	15 (17.4%)	8 (9.3%)	2.52	1.35
I am comfortable integrating AI tools into existing library services.	46 (41.9%)	7 (8.1%)	15 (17.4%)	14 (16.3%)	14 (16.3%)	2.57	1.55
I can use AI to enhance information retrieval processes in my library.	53 (50%)	7 (8.1%)	9 (10.5%)	16 (18.6%)	11 (12.8%)	2.36	1.54
I have designed AI-powered personalized learning experiences for library users.	42 (37.2%)	17 (19.8%)	18 (20.9%)	12 (14%)	7 (8.1%)	2.36	1.32

4.4 Current level of AI literacy (Normative competencies)

Table 4 shows that the Normative competencies of library professionals were also measured using a five-point Likert scale, and the results highlight that professionals possess limited awareness and understanding of AI-related ethical, privacy, and accountability concerns. More than 50% participants disagreed and strongly disagreed with the statements that they could identify the biases in AI algorithms, and they were unaware of AI's privacy policies (M=2.38, SD=1.30). Table 4 also elaborated that the majority were unable to evaluate the reliability or accuracy of AI tools. Similarly, the mean score for normative competencies remained under 3, which shows a low level of normative competencies among library professionals, as they lack confidence in handling AI-related ethical and accountability issues.

Table 4

Current level of AI literacy (Normative competencies) (N=96)

Statement	SD	D	N	A	SA	Mean	SD
I can identify potential biases in AI algorithms and their outputs.	41 (36%)	15 (17.4%)	23 (26.7%)	10 (11.6%)	7 (8.1%)	2.38	1.30
I am aware of the privacy implications of using AI in library services.	48 (44.2%)	4 (4.7%)	25 (29.1%)	12 (14%)	7 (8.1%)	2.37	1.38
I can critically evaluate the reliability and accuracy of AI generated information.	43 (38.4%)	8 (9.3%)	22 (25.6%)	10 (11.6%)	13 (15.1%)	2.56	1.48



I understand the ethical considerations of using AI in information retrieval and dissemination.	51 (47.7%)	3 (3.5%)	14 (16.3%)	15 (17.4%)	13 (15.1%)	2.49	1.57
I can explain the concept of AI accountability to library users	52 (48.8%)		19 (22.1%)	14 (16.3%)	11 (12.8%)	2.44	1.53

4.5 Essential AI Literacy Skills and Knowledge Areas

Library professionals were asked to share their perception about the essential AI literacy skill areas on a five-point Likert scale. The results in Table 5 shows a varying level of participants agreement with the statements. Majority of the participants were strongly disagreed (40.7%), that understanding AI algorithms and machine learning is crucial for LIS professionals (M=2.76, SD=1.65). Majority of the participants showed their agreement with the inclusion of AI tools in LIS education as 36% were strongly agreeing and 10.5% were agreeing. It is important to mention that that 40.7% strongly disagreed, showing that not all respondents see practical AI training as essential. However, the mean score of this statement showed that majority was agreed with the inclusion of AI tools in LIS education (M = 3.00, SD = 1.79). For knowledge of data management and analysis, participants gave mix opinions as around 45 percent were disagreed while 46 percent were agreed that data management and analysis are crucial for working with AI in libraries. For critical thinking skills, there was a division in perception, with some LIS professionals recognizing the importance of critical evaluation, as 34.9% strongly agreed, and 14% agreed that critical thinking skills are essential for assessing AI tools, while 43% strongly disagreed. Thus, both the statements critical thinking skills for evaluating AI tools (M = 2.98, SD = 1.81) and knowledge of data management and analysis (M = 2.86, SD = 1.79) were acknowledged as crucial, but a significant number of respondents remained neutral or disagreed on their necessity. Understanding the Societal Impact of AI received a relatively balanced response, with 32.6% strongly agreeing and 12.8% agreeing that LIS professionals should understand AI's societal impact (M = 3.00, SD = 1.73).

Table 5

Essential AI Literacy Skills (N=96)

Statement	SD	D	N	A	SA	Mean	SD
I believe understanding AI algorithms and machine learning principles is crucial for LIS professionals.	45 (40.7%)	3 (3.5%)	17 (19.8%)	10 (11.6%)	21 (24.4%)	2.76	1.65
I think practical experience with AI tools should be a core component of LIS education.	45 (40.7%)	1 (1.2%)	10 (11.6%)	9 (10.5%)	31 (36%)	3.00	1.79
Knowledge of data management and analysis is essential for working with AI in libraries.	49 (45.3%)		7 (8.1%)	14 (16.3%)	26 (30.2%)	2.86	1.79
I believe critical thinking skills for evaluating AI tools are vital for LIS professionals.	47 (43%)		7 (8.1%)	12 (14%)	30 (34.9%)	2.98	1.81
Understanding the societal impact of AI should be part of the LIS curriculum.	42 (37.2%)	3 (3.5%)	12 (14%)	11 (12.8%)	28 (32.6%)	3.00	1.73

4.6 Effectiveness of Existing AI Literacy Training

Table 6 revealed the experiences of library professionals with AI literacy trainings, majority showed dissatisfaction about the comprehensiveness of training. A considerable number of respondents (37.2%) expressed strong disagreement, while another 17.4% disagreed, regarding their participation in AI literacy training programs tailored for library professionals. Only 12.8% showed agreement, and just 8.1% strongly



agreed, implying that there are limited opportunities for AI training in the Library and Information Science (LIS) sector ($M = 2.37, SD = 1.32$). Moreover, a substantial number of respondents (41.9%) remained neutral, reflecting uncertainty or indifference about the training's coverage of essential topics. In addition, 25.6% strongly disagreed and 16.3% disagreed, which indicates that a significant proportion felt the training was lacking in depth ($M = 2.58, SD = 1.21$). Similarly, 44.2% of participants maintained a neutral stance on whether the training effectively prepared them to use AI tools in practical scenarios, while 26.7% strongly disagreed and 14% disagreed. Notably, 31.4% expressed neutrality, yet a substantial 34.9% strongly disagreed, and 11.6% disagreed regarding the training's address of ethical issues surrounding AI. In terms of confidence in applying the AI knowledge gained, 33.7% strongly disagreed and 8.1% disagreed, while 37.2% remained neutral. This highlights that many professionals do not feel sufficiently equipped to implement AI concepts in their work. Overall, these findings indicate that AI literacy training for LIS professionals is either insufficient or lacks accessibility for many respondents. Even among those who have undergone training, there is a notable lack of confidence and dissatisfaction concerning the comprehensiveness of what was provided. The mean scores across all statements fall below 3.0, which suggests a low to moderate effectiveness of AI training programs.

Table 6

Effectiveness of Existing AI Literacy Training (N=96)

Statement	SD	D	N	A	SA	Mean	SD
I have participated in AI literacy training programs specifically designed for library professionals.	42 (37.2%)	15 (17.4%)	21 (24.4%)	11 (12.8%)	7 (8.1%)	2.37	1.32
The AI literacy training I received was comprehensive and covered all necessary aspects.	32 (25.6%)	14 (16.3%)	36 (41.9%)	6 (7%)	8 (9.3%)	2.58	1.21
The training effectively prepared me to use AI tools in my daily work.	33 (26.7%)	12 (14%)	38 (44.2%)	7 (8.1%)	6 (7%)	2.55	1.17
The training addressed ethical considerations of AI use in libraries.	40 (34.9%)	10 (11.6%)	27 (31.4%)	11 (12.8%)	8 (9.3%)	2.50	1.33
I feel confident applying the knowledge gained from AI literacy training in my professional practice.	39 (33.7%)	7 (8.1%)	32 (37.2%)	1 (12.8%)	7 (8.1%)	2.53	1.29

4.7 Ethical Considerations and Challenges

Table 7 highlights critical ethical concerns and challenges surrounding AI implementation in library services. A notable 38.4% of respondents strongly disagreed, and 5.8% disagreed, that they are worried about privacy breaches associated with AI, resulting in a mean score of 2.66 ($SD = 1.54$) that indicates moderate concern. Concerns about AI amplifying biases in information retrieval are significant, with 32.6% strongly disagreeing and 7% disagreeing. This reflects a need for greater awareness as many LIS professionals recognize these risks, while others remain indifferent. Transparency in AI tools is a pressing challenge, with 38.4% strongly disagreeing and 7% disagreeing regarding difficulties in this area. Additionally, many feel low confidence in handling AI ethics—27.9% reported neutrality, while only 16.3% agreed and 10.5% strongly agreed, indicated by a mean score of 2.07 ($SD = 1.38$). A strong consensus exists on the need for clear ethical guidelines for AI use in libraries, with 38.4% strongly agreeing and 14% agreeing. However, 8.1% remained neutral, and 38.4% strongly disagreed. These findings underscore that while privacy, bias, and transparency are vital concerns, many library professionals feel unprepared to address these ethical challenges effectively. Prioritizing the establishment of ethical frameworks is crucial as AI technologies evolve.



Table 7

Ethical Considerations and Challenges (N=96)

Statement	SD	D	N	A	SA	Mean	SD
I am concerned about potential privacy breaches when using AI in library services.	43 (38.4%)	5 (5.8%)	22 (25.6%)	10 (11.6%)	16 (18.6%)	2.66	1.54
I worry about the potential for AI to perpetuate or amplify biases in information retrieval.	38 (32.6%)	6 (7%)	19 (22.1%)	12 (14%)	21 (24.4%)	2.91	1.58
I find it challenging to ensure transparency when using AI powered tools in library services.	43 (38.4%)	6 (7%)	25 (29.1%)	13 (15.1%)	9 (10.5%)	2.13	1.37
I am confident in my ability to address ethical issues related to AI use in libraries.	45 (40.7%)	4 (4.7%)	24 (27.9%)	14 (16.3%)	9 (10.5)	2.07	1.38
I believe there should be clear guidelines for the ethical use of AI in library and information services.	43 (38.4%)	1 (1.2%)	7 (8.1%)	12 (14%)	33 (38.4%)	2.70	1.87

4.8 Inferential Statistics- Independent Sample T test

An Independent sample t test was employed to check the difference of opinion among male and female library professionals. Table 8 explains the results for independent sample t test, which clearly shows that there is no statistically significant difference between male and female library professionals. A difference in the mean value is recorded but the p-values for all variables exceed the significance threshold of $p < .05$. Thus, these results suggest that gender is not a determining factor in AI literacy development within library professionals.

Table 8

Independent Sample T test (N=96)

Variables	Male N=48		Female N=38		t	p
	M	SD	M	SD		
CCC	2.67	1.41	2.80	1.41	-.419	.676
CBC	2.40	1.22	2.41	1.13	-.009	.993
CNC	2.49	1.22	2.38	1.24	.398	.691
EAIL	2.88	1.42	2.96	1.36	-.263	.793
AILTER	2.47	1.10	2.55	1.11	-.340	.735
Ethical Con	2.69	1.21	2.81	1.15	-.481	.632

Note. No statistically significant differences were found ($p > .05$ for all comparisons). Levene's test for equality of variances was non-significant for all variables, supporting the assumption of homogeneity of variance.

4.9 Inferential Statistics- ANOVA

One way was employed to check the difference of opinion based on age, experience, education and type of library they work in. The results in Table 9 shows that there is no statistically significant difference in the perception of participants based on various age groups as all p-values exceed the conventional threshold of 0.05. Thus, it can be concluded that age doesn't affect the perception of library professionals, however, a variation in the mean values is recorded as for ethical consideration as the age group (35-44) reported a higher mean value (M = 2.96, SD = 1.29).



Table 9

Anova Test for Age groups (N=96)

Variables	25-34		35-44		45-54		54 & above		t	p
	M	SD	M	SD	M	SD	M	SD		
CCC	2.68	1.17	2.88	1.62	2.71	1.32	2.40	1.36	.338	.798
CBC	2.18	1.05	2.49	1.37	2.29	1.14	2.70	0.86	.508	.678
CNC	2.56	1.06	2.55	1.38	2.41	1.21	2.16	1.01	.317	.813
EAIL	2.84	1.33	3.01	1.55	2.95	1.33	2.65	1.30	.207	.891
AILTER	2.22	0.93	2.49	1.25	2.66	1.12	2.35	0.72	.512	.675
Ethical Con	2.46	0.93	2.96	1.29	2.79	1.20	2.30	0.92	1.12	.343

Note. Value is significant $p < .05$

Next, there were four groups of experiences, and the results (Table 10) again indicate that there is no statistically significant difference across experience levels. However, a slight variation in the mean values across various experience-based groups is observed.

Table 10

Anova Test for Experience (N=96)

Variables	0-5		6-10		11-15		15 & above		t	p
	M	SD	M	SD	M	SD	M	SD		
CCC	2.48	1.22	2.85	1.13	2.56	1.55	2.79	1.45	.202	.895
CBC	2.31	1.06	1.90	0.88	2.17	1.32	2.58	1.17	1.14	.336
CNC	2.51	1.01	2.37	1.16	2.17	1.21	2.55	1.27	.441	.724
EAIL	3.14	0.93	3.15	2.02	2.47	1.42	3.00	1.33	.797	.499
AILTER	2.51	0.82	1.75	0.81	2.38	1.35	2.66	1.05	1.71	.171
Ethical Con	2.60	0.98	3.05	0.86	2.52	1.32	2.79	1.21	.449	.719

Note. Value is significant $p < .05$

Furthermore, the difference of perception based on different educational level was observed by using one-way Anova. The results in Table 11 also indicates that there is no statistically significant difference in the perception of professionals based on different educational levels. However, the mean value shows that Bachelor's degree holders (M = 3.28, SD = 1.26) reported slightly higher ethical conduct perceptions compared to Master's (M = 2.54, SD = 1.11) and PhD holders (M = 2.69, SD = 1.16), the result is not statistically significant.

Table 11

ANOVA for Education Levels (N=96)

Variables	Bachelor		Master		PhDs		t	p
	M	SD	M	SD	M	SD		
CCC	2.93	1.58	2.59	1.28	2.81	1.53	.455	.636
CBC	2.45	1.46	2.38	1.06	2.42	1.19	.026	.974
CNC	2.26	1.44	2.49	1.12	2.52	1.26	.281	.756
EAIL	3.21	1.64	2.95	1.24	2.62	1.44	.967	.384
AILTER	2.59	1.53	2.48	0.89	2.47	1.09	.067	.935
Ethical Con	3.28	1.26	2.54	1.11	2.69	1.16	2.75	.070

Note. Value is significant $p < .05$

Last but not the least, the difference in the perception of librarians working in different work environment such as university/college libraries, school or special libraries was observed. Table 12 highlighted that there are no statistically significant differences in workplace climate perceptions based on institutional type, as all p-values exceed 0.05. This suggests that working in a university/college, school, or special institution does not significantly alter perceptions of library professionals.



Table 12

ANOVA for Types of Libraries (N=96)

Variables	Uni/College		School		Special		<i>t</i>	<i>p</i>
	M	SD	M	SD	M	SD		
CCC	2.72	1.43	2.70	1.38	2.82	1.60	.024	.976
CBC	2.41	1.16	2.32	1.22	2.66	1.22	.294	.746
CNC	2.51	1.19	2.32	1.21	2.57	1.51	.266	.767
EAIL	3.02	1.42	2.76	1.27	2.93	1.71	.320	.727
AILTER	2.47	1.07	2.61	1.13	2.31	1.23	.279	.757
Ethical Con	2.74	1.23	2.77	1.14	2.68	1.14	.020	.981

5. Discussion

The study aimed to investigate the current level of AI literacy among library professionals from Saudi Arab. Quantitative research approach was employed to collect data by using a close ended questionnaire. Based on the results, the findings revealed that library professionals possess limited AI literacy specifically in terms of cognitive competencies. The results highlighted that library professionals are struggling with AI principles, differentiating AI technologies, and integrating AI applications to enhance library services. This result aligns with the existing literature which highlight that AI literacy includes the understanding or features of AI, processing and influence of algorithm (Almatrafi et al., 2024; Yuan et al., 2024). Though they are familiar with the AI tools that can be used in the library settings for an enhanced efficiency of library services. However, awareness alone is not sufficient, therefore, professionals need more in-depth training to ensure that professionals are able to assess and integrate AI technologies in their work (Almatrafi et al., 2024).

However, the interpretation of mean scores around 2.5–3.0 as 'low' should be made with caution, as the scale midpoint is 3.0 (neutral). This suggests that while participants did not actively endorse AI literacy competencies, they also did not strongly reject them, indicating potential for improvement rather than complete absence of knowledge. For behavioural competencies, majority of library professionals were found with minimal experience using AI tools for their daily tasks, AI driven bibliographic records, data analysis and information retrieval. They were found with lack of confidence in integrating AI into routine library operations which shows that there is a gap between practical and theoretical knowledge (Lo, 2024; Yuan et al., 2024). Overall, this suggests that library professionals were not actively involved in AI based practices which means that there is a need for skills building initiatives. It is also argued by Kautonen and Gasparini (2024), "learning-by-doing" approach is critical in fostering AI competencies, particularly in the library settings.

Next, there were normative competencies, which mainly deals with ethical awareness and accountability issues for using AI tools, were also found low among library professionals. Professionals highlighted that they were unable to understand AI algorithms and in evaluating the reliability of AI tools. The limited awareness of these issues reflects findings from Almatrafi et al. (2024) and Yuan et al. (2024), who argue that normative competencies, such as understanding ethical implications and evaluating AI threats, are vital components of AI literacy. The limited awareness of AI-related privacy policies and ethical considerations suggests a pressing need for training programs that address these concerns. Thus, the result for normative competencies suggests the need for tailored interventions to discuss the AI implementation in libraries and information centres. Library professionals suggested that it is important to inculcate the AI literacy such as data management, AI algorithms, and critical thinking etc. in LIS programs as AI education is very important for professionals. Therefore, it is crucial for professionals to learn AI for improving library services. Kizhakkethil & Perryman (2024) and Chigwada (2024) also recommended the embedment of AI literacy in the curricula to prepare librarians for the challenges and opportunities AI tools.

Dissatisfaction with current AI literacy training programs is also highlighted by the data. Even professionals who have taken part in AI training programs believed they were insufficient, and many others reported having little access to it. The lack of confidence in realistically using AI knowledge further emphasized the necessity for thorough and easily available AI literacy programs designed for LIS



professionals. Another major issue was the difficulties and ethical issues surrounding the application of AI. Transparency problems, biases in AI-powered systems, and privacy violations were noted as major obstacles. The necessity for explicit ethical guidelines and regulations to enable responsible AI integration in libraries was emphasized by the many experts who voiced concerns about how to handle ethical dilemmas linked to AI.

Independent sample t-test and one-way Anova was employed to check the difference of perception of library professionals based on their demographical information. The results for inferential statistics revealed that there is no significant difference in AI literacy of library professionals based on any demographical variable. These results indicate that there is a systemic need for capacity-building efforts across the LIS sector. Concluding this, the study summarized that there is an urgent need for tailored AI Interventions for library professionals. It is imperative to address the literacy gaps that exists to ensure that library professionals are able to integrate the AI tools in library services for better and improved service provision.

The findings of this study are consistent with recent research in other non-Western contexts. For example, Subaveerapandiyana & Gozali (2024) reported similar gaps in AI literacy among Indian library professionals, suggesting that systemic challenges such as lack of training infrastructure and ethical guidelines may be shared across developing countries. This comparability enhances the external validity of the present findings.

6. Conclusion

This study concludes that library professionals in Saudi Arabia possess moderate to low AI literacy across cognitive, behavioural, and normative dimensions. While awareness of AI's potential exists, practical application and ethical understanding remain underdeveloped. Importantly, demographic variables such as gender, age, education, experience, and library type do not significantly influence AI literacy levels, suggesting that the gaps are systemic rather than subgroup-specific. These findings underscore the urgent need for structured, accessible, and ethically grounded AI training programs tailored to the library and information science workforce in Saudi Arabia.

7. Limitations

Several limitations should be acknowledged. First, the study employed a convenience sampling method, which limits the generalizability of findings to all library professionals in Saudi Arabia. Second, the sample size (N=96) is relatively small, and a larger, randomly selected sample would provide more robust estimates. Third, the self-reported nature of the survey may introduce social desirability and recall biases. Fourth, the cross-sectional design captures AI literacy at a single point in time and cannot assess changes following training interventions. Fifth, the lack of qualitative data limits depth in understanding why certain competencies are low. Finally, the absence of a validated, widely accepted AI literacy scale for library professionals means that comparisons across studies should be made cautiously. Future research should address these limitations through mixed-methods designs, longitudinal tracking, and the development of standardized AI literacy instruments for the LIS profession.

8. Theoretical Implications

This study contributes to the limited body of literature on AI literacy in non-Western library contexts. By applying a tripartite framework (cognitive, behavioural, normative), the study demonstrates that these dimensions are empirically distinguishable yet collectively low among Saudi library professionals. This finding supports the multidimensional conceptualization of AI literacy proposed by Almatrafi et al. (2024) and Yuan et al. (2024) while extending it to a new geographical and professional context. Additionally, the lack of significant demographic differences suggests that AI literacy gaps are structural rather than individual, pointing to the need for systemic-level theoretical models.

9. Practical Implications

Based on the findings, the following actionable recommendations are proposed:

1. Tailored Training Programs: Develop modular, hands-on AI literacy workshops focusing on practical skills (e.g., using ChatGPT for cataloguing, AI-powered data analytics) rather than solely theoretical content.



2. Ethical Guidelines: Library administrations should establish clear, written ethical guidelines for AI use, addressing privacy, bias, transparency, and accountability.
3. Curriculum Integration: LIS graduate programs should integrate AI literacy as a core competency, including courses on AI fundamentals, ethical AI, and human-AI collaboration.
4. Continuous Professional Development: Establish learning circles, webinars, and certification programs to support lifelong learning among practicing librarians.
5. Collaborative Framework: Partner with IT departments, faculty, and professional library associations to co-design scalable AI literacy initiatives.

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Contribution of Authors

All the authors participated in the ideation, development, and final approval of the manuscript, making significant contributions to the work reported.

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The authors declare no conflicts of interest.

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Informed Consent

Informed consent was obtained from all individual participants included in the study.

Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Data Availability

The datasets generated during and analysed during the current study are available from the corresponding author on reasonable request.

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