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Knowledge, Attitudes and Perception of Nursing Students about Artificial Intelligence in India

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Abstract

In recent times, nursing students have been utilizing artificial intelligence (AI) technology, as they perceive it boosts learning outcomes and academic performance and transforms several facets of healthcare. This study aimed to explore nursing students' knowledge, attitudes and perceptions concerning the adoption of AI in their academic and clinical areas. It applied an exploratory study design to cover the study population of all undergraduate students, including interns from selected private nursing colleges in Tamil Nadu, India (N = 440). A self-designed online questionnaire was distributed via Google Forms to the target population and 317 responded. The results showed that 81.3% were familiar with the term "AI" (81.3%). 76.3% recognized that AI would revolutionize the nursing field. Most nursing students consented that AI should be included in undergraduate (67.2%) and postgraduate (71.3%) nursing curricula. 77.9% perceived that AI would be helpful for their future career. A significant variation was observed in nursing students' knowledge, attitude and perception scores across age categories, but not for gender and year of study. This study concluded that female nursing students, especially those aged 17-19, demonstrated strong knowledge, an optimistic attitude and had a better perception of AI. The findings suggest that nursing students in India possess adequate knowledge about AI, indicating a positive perception that AI plays a transformative function in nursing education and practice, with a need for more focused training and integration into the curriculum.

Keywords: Artificial intelligence, Attitude, India, Knowledge, Nursing students, Perception.

Introduction

With the increasing demand for healthcare professionals (HCPs) due to a rapidly aging population and the impact of a global pandemic, the need for well-trained nurses has never been more critical. Today's nursing programs emphasize delivering high-quality, evidence-based care across a range of healthcare environments, including clinics, hospitals and long-term care facilities. By combining classroom learning, hands-on training and clinical experiences, nursing students are ready to guide the intricacies of the health sector (1). Recently, there has been an increasing trend in the adoption of technology for learning and instructional processes regarding nursing education (2). Notably, nursing students used artificial intelligence (AI) technology because they believed it improved learning outcomes and academic performance (3). AI is innovative

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technology highly influencing nursing, midwifery and healthcare (4). The rapid advancement of AI tools is transforming healthcare, impacting areas such as patient care, diagnosis and administrative efficiency (5). On the other hand, in academia, AI analytics enables instructors to understand students' performance, progress and potential by analyzing their clickstream data (6). Furthermore, AI analytics enables educators to comprehend students' achievement, progress and strengths by exploring their data (6). Furthermore, AI can support nurses in taking on a more extensive role in delivering healthcare services by offering advanced tools that help them at all times. This condition allows nurses to meet their practitioner role and deliver nursing care (7). It is redesigning patient care in nursing by improving monitoring processes, ensuring medication safety, increasing patient involvement, optimizing resource allocation and effectively managing electronic health records. Nursing schools must adopt AI to provide better, more efficient and safer patient care, as technology has advanced in recent years (8). As such, the integration of AI in higher education has gained global awareness, prompting various nations to invest in research and academic initiatives related to AI. China established a contemporary AI plan to position the nation as an international AI powerhouse by 2030 and will achieve improvements across various aspects of fundamental AI research. It provided awareness programs to improve public acceptance of AI. Further, the number of AI programs offered was observed to assess the innovation power of the higher education sector, thereby attracting technology and human capital (9). Besides, the European Union's Digital Education Action Plan (2021-2027) focused on improving student learning and helping higher education faculty and administrators by encouraging the use of AI (10). The National Science Foundation invests in AI education and research in the United States, with a focus on enhancing equity through AI-enhanced learning for adult learners (11). These global investments in AI instruction and research aim to cultivate leadership and equip students for the upcoming job demands.

AI technology holds significant promise for enhancing nursing education by developing complex and refined simulations that foster critical thinking and equip students for real patient care scenarios. With these simulations, students can rehearse clinical skills and make decisions in a protected atmosphere through real scenarios that closely resemble patient care concerns. As AI advances, increasingly sophisticated simulations are emerging, offering a more natural and engaging educational experience. In nursing education, simulation is used to teach academic and practical skills and to promote students' critical thinking ability. Simulation allows students to practice in a climate that resembles a clinical setting, helping them acquire clinical nursing experience that supports their professional careers (12). AI can enhance simulation by presenting practical, customized scenarios tailored to students' individual learning needs (13). The advantages of AI in nursing education, comprising time-saving features and interactive learning opportunities, are unquestionable. However, potential threats require a prudent, scholarly method to AI use (14). AI can also help nursing students learn more about current research and evidence-based practices by analyzing large-scale clinical data to identify best practices, patterns and areas for improvement. AI-enhanced academic tools can evaluate each student's strengths and weaknesses, thereby tailoring learning experiences accordingly. By integrating AI into nursing education, future HCPs will be adequately prepared to meet the needs of the healthcare industry (8). At the same time, students should be exposed to the ethical use of AI-powered tools in educational environments, enabling them to assess their suitability and minimize associated risks. Nursing students should learn to use AI effectively and understand the benefits and risks of AI-powered tools (15).

Several global researchers have studied the knowledge, attitudes and perceptions of AI among nursing students (16-19). However, few studies have been conducted in India; only a few have analyzed the knowledge, attitudes and perceptions of AI among nursing students (20, 21). To contribute to the existing literature, this study focuses to address the following research objectives:

i) to reveal nursing students' knowledge, attitudes and perceptions regarding AI at selected nursing colleges in Tamil Nadu, India,

ii) to identify variations in nursing students' knowledge, attitudes and perceptions concerning their demographic variables and
iii) to uncover the associations between nursing students' knowledge, attitudes and perceptions and their demographic variables.

Besides, this study would make a significant contribution to the expanding research on nursing students' knowledge, attitudes and perceptions of AI, particularly among selected nursing colleges in Tamil Nadu, India. Also, it provides valid information on variations in nursing students' viewpoints on AI across demographic variables. It provides a validated, self-structured questionnaire for researchers to assess nursing students' knowledge, attitudes and perceptions of AI. Notably, this study would provide vital regional baseline information and valuable insights to nursing educators and policymakers, facilitating the ethical and practical integration of AI into nursing education.

Methodology

Study Design

An exploratory study design was used to evaluate undergraduate nursing students' knowledge, attitudes and perceptions regarding the adoption of AI in academic and clinical settings.

Study Setting and Participants

The study population comprised all undergraduate students studying across the state of Tamil Nadu, India. As it was hard to precisely predict the total number of nursing students enrolled in Tamil Nadu colleges, the required sample size is fixed through the following formula calculating the sample size for an infinite population, i.e., Z^2 x p x (1-p) / C^2 "Z score for 95% confidence level = 1.96"; "p = percentage of population assumed as 55% or 0.55"; and "c = confidence interval or margin of error = 0.05 or 5%" (22). Using these parameters, an anticipated sample size of 380 was observed with a 95% CI and a 5% margin of error. Subsequently, this study targeted nursing students currently enrolled in selected private nursing colleges (N=8), as shown in Table 1 and used convenience sampling. It sent the online questionnaire to 400 students via Google Forms and 337 were completed, representing an 84% response rate. Furthermore, this study was conducted between September 2024 and December 2024. It obtained formal ethical approval from the Institutional Ethics Committee of Dr. Kumaraswami Health Center, College of Nursing.

Table 1: Sampling Sites and their Global Positioning System Coordinates

Sampling Site	Global Positioning System (GPS) Coordinates	Location
1	8.1123249, 77.5338028	Kanyakumari
2	13.0730° N, 80.1550° E	Chennai
3	12.0739, 79.4877	Villupuram
4	8.3656, 77.2879	Kanyakumari
5	11.4456, 77.6947	Komarapalayam
6	11.278° N, 77.346° E	Tiruppur
7	11.4549° N, 77.6937° E	Komarapalayam
8	10.9397° N, 79.3815° E	Kumbakonam

Measurement and Data Collection

Through an exploration of literature, this study developed the knowledge, attitude and perception questionnaire (19, 23-29). This self-structured questionnaire contains items that assess nursing students' knowledge, attitudes and perceptions of AI. It includes four parts. Part A presents demographic details of nursing students, including gender, age, year of study and frequency of AI use. Part B consists of 5 items that evaluate students' knowledge of AI. Part C includes 8 items assessing students' attitudes towards AI. Part D comprises seven items that measure students' perceptions of AI. The responses toward the knowledge, attitude and perception items are measured using a "5-point Likert scale," i.e., "strongly agree [5]," "agree

[4]," "neutral [3]," "disagree [2]," and "strongly disagree [1]".

Besides, the nursing students' knowledge, attitude and perception scores were categorized grounded on the percentile score, as observed in the previous study (23, 30), i.e., "the percentage of individual score is calculated based on the score obtained by an individual, divided by the total obtainable score and multiplied by 100." An earlier study used cut-offs of >75% and <75% to classify knowledge and attitude scores (31). A recent study has applied "Bloom's cut-off point" and characterized overall knowledge, attitude and practice (KAP) into three categories, i.e., "Good-80-100%," "Moderate-60-79%," and "Poor-<60%" (32). Another recent study adopted two categories instead of three by merging 'Good' and 'Moderate' into one category and retaining 'Poor' (<60%) as a separate category. A score between 60% and 100% indicated that the KAP domain was sufficient and a score <60% indicated that the KAP domain was insufficient (33). Based on this published literature, this study considered two categories for describing knowledge, attitude and perception scores, i.e., Knowledge – Good (60-100%) and Poor (<60%), Attitude – Positive (60-100%) and Negative (<60%) and Perception – Positive (60-100%) and Negative (<60%).

All participants were assured that the data would be kept confidential and anonymous. They were informed about the study objectives and that their data would be used only for research purposes. Additionally, they were asked to participate voluntarily and could withdraw from the research study at any time. They were asked to complete the questionnaire after providing informed consent. The questionnaire remained live for a sufficient period, allowing participants to respond. Frequent reminders were provided to all students to encourage their participation in responding to the questionnaire. All the completed questionnaires were subjected to statistical analysis and the gathered data (N = 317) were examined using appropriate statistical tools and techniques.

Data Analysis

The data analysis was carried out using SPSS version 27. Cronbach's alpha and factor analysis were conducted to assess the questionnaire's reliability and validity. The Kolmogorov-Smirnov test was used to verify the normality of the data, which was observed to be non-normal. The descriptive statistics were applied to describe students' demographic traits, self-reported knowledge of AI in academia and perceptions and attitudes toward AI. Furthermore, the chi-square test was applied to assess the association between demographic variables and questions on knowledge, attitude and perception. Besides, the Mann–Whitney U test and Kruskal-Wallis H test were utilized to compare the mean knowledge, attitude and perception scores regarding nursing students' gender, age and year of study. The significance level was fixed at 5% ($p < 0.05$).

Results

Reliability and Validity of the Questionnaire

This study found that the questionnaire's overall Cronbach's alpha was 0.901, indicating that the questionnaire could be graded as "Excellent" (34-36). Additionally, the Cronbach's alphas for the knowledge, attitude and perception domains were 0.831, 0.784 and 0.815, respectively. While reviewing the factor analysis outcomes, the statistical criterion, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy, was 0.891 and Bartlett's test of sphericity yielded a significant Chi-square value (3014.546; $p < 0.05$). These results affirmed that the raw data were appropriate for performing factor analysis. The questionnaire items showed a communality value exceeding 0.50, i.e., the guided threshold (37-39), pointing to satisfactory measurement quality and no items were deleted. The total variance observed in the varimax rotation accounted for 61% of the variance, which is above the acceptable threshold of 60% (40).

Demographic Characteristics

Out of 317 nursing students, most were females (86.6%) and aged between 17 and 19 (61.2%). 29.7% and 29.3% belonged to the first and fourth year of the study, respectively. Only a small percentage of nursing students were interns (3.8%), as shown in Table 2. Moreover, Figure 1 illustrates that 40.1% of nursing students sometimes use AI tools for study purposes. 22.7% and 18.9% used them always and often,

respectively. However, only 8.8% had never used them for study purposes.

Table 2: Demographic Characteristics

Demographic variables	Category (n=317)	n (%)
Gender	Male	36(11.4)
	Female	281(86.6)
Age	17 - 19	139(61.2)
	20 - 22	129(40.7)
	23 and above	49(15.5)
Year of Study	First Year	94(29.7)
	Second Year	76(24.0)
	Third Year	42(13.2)
	Fourth Year	93(29.3)
	Internship	12(3.8)

Note: n= Number of participants, %= percentage.

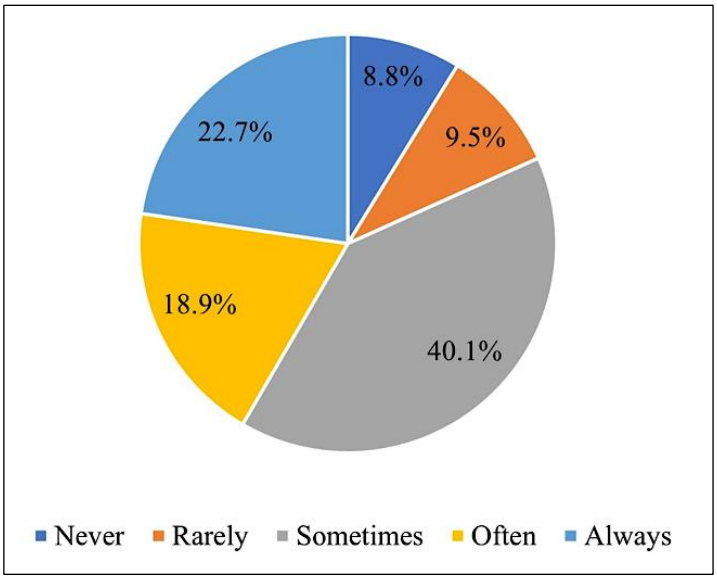

Figure 1: Distribution of Nursing Students using AI tools for Study Purposes

Table 3: Nursing Students' Knowledge about Artificial Intelligence

Items	Sample Responses	
	Strongly Agree/Agree n (%)	Neutral/ Disagree/ Strongly Disagree n (%)
Are you familiar with the term "artificial intelligence?"	259(81.3%)	58 (18.5%)
Do you possess the basic knowledge about the working principles of artificial intelligence	212(66.9%)	105(33.1%)
Do you have a basic understanding of the application of artificial intelligence in the nursing field	236(74.5%)	81(25.5%)
Have you attended any online/offline courses regarding artificial intelligence to gain knowledge	143(45.2%)	174(54.8%)
Are you aware of the limitations of artificial intelligence	223(69.2%)	73(33.3%)

Note: n= Number of participants, %= percentage.

Table 4: Nursing Students' Attitude and Perception About Artificial Intelligence in Academics and Clinical Areas

Items	Strongly Agree n (%)	Agree n (%)	Neutral n (%)	Disagree n (%)	Strongly Disagree n (%)
Attitude-related items					
AI will revolutionize the nursing field	106(33.4%)	136(42.9%)	65(20.5%)	5(1.6%)	5(1.6)
AI applications should be part of the undergraduate nursing curriculum	72(22.7%)	141(44.5%)	97(30.6%)	7 (2.2%)	0.(0.0%)
AI applications should be part of the postgraduate nursing curriculum	85(26.8%)	141(44.5%)	78(24.6%)	11 3.5%)	2(0.6%)
AI may replace nurses in the future	45(14.2%)	106(33.4%)	131(41.3%)	23(7.3%)	12(4%)
AI will never make the human nurse expendable	41(12.9%)	118(37.2%)	139(43.8%)	19 6.0%)	0(0.0%)
The use of AI in nursing is exciting	87(27.4%)	137(43.2%)	87(27.4%)	6(1.9%)	0(0.0%)
Nursing students must understand the ethical implications of AI	102(32.2%)	161(50.8%)	50(15.8%)	4(1.3%)	0(0.0)
I am interested in using artificial intelligence in nursing	127(40.1%)	129(40.7%)	48(15.1%)	12(3.8%)	1(0.3%)
Perception-related Items					
AI can perform better than humans	101(31.9%)	125(39.4%)	54(17.0%)	32(10.1%)	5(1.6%)
AI will cause more benefits than harm	79(24.9%)	139(43.8%)	79(24.9%)	15(4.7%)	5(1.6%)
AI applications will be cost-effective	41(12.9%)	116(36.6%)	122(38.5%)	30(9.5%)	8(2.5%)
AI can speed up the nursing care process	124(39.1%)	110(34.7%)	65(20.5%)	17(5.4%)	1(0.3%)
AI can help reduce the number of medical errors.	95(30.0%)	136(42.9%)	60(18.9%)	25(7.9%)	1(0.3%)
AI can improve nursing decision-making.	83(26.2%)	132(41.6%)	71(22.4%)	29(9.1%)	2(0.6%)
AI will be helpful for my future career.	135(42.6%)	112(35.3%)	57(18.0%)	11(3.5%)	2(0.6%)
Overall perception about AI	86(27.1%)	147(46.4%)	79(24.9%)	2(0.6%)	3(0.9%)

Note: n= Number of participants, %= percentage.

Nursing Students' Knowledge about AI

Table 3 indicates that 81.3% were familiar with the term "AI," and 66.9% had fundamental knowledge of AI's working principles. Most nursing students understood AI applications in nursing (74.4%) and their limitations (69.2%). Only 45.1% had previously attended online/offline courses to gain knowledge about AI.

Nursing Students' Attitude and Perception about AI

Table 4 shows that 76.3% of nursing students agreed that AI would revolutionize the nursing field. Most students stated that AI should be part of the undergraduate (67.2%) and postgraduate (71.3%) nursing curriculum. Around half of nursing students (47.6%) agreed that AI might substitute nurses in the future and 50.1% believed it would never make human nurses expendable. However, about 40% were neutral to these two statements. Most nursing students (70.6%) were excited and (80.8%) were interested in AI. Notably, 83% of nursing students agreed they must understand AI's ethical implications. Besides, 71.3% agreed that AI could perform better than humans and 68.7% perceived that it would cause more benefits than harm. Nevertheless, 49.5% felt that AI would be cost-effective. Most nursing students stated that AI could speed up nursing care (73.8%) and help reduce medical errors (72.9%).

67.8% felt that AI could improve nursing decision-making and 77.9% agreed that AI would be helpful for their future career.

Comparison of Nursing Students' Mean Knowledge, Attitude and Perception Scores Concerning their Demographical Variables

Table 5 indicates that there are no significant variations in knowledge, attitude and perception domain scores regarding gender ($p > 0.05$) Similarly, no significant variationspwere detected in those scores across the years of study of the participating nursing students ($p > 0.05$). However, there is a significant variation in the nursing students' mean knowledge, attitude and perception scores across their age categories ($p < 0.05$).

Association of Nursing Students' Knowledge, Attitude, Perception with their Demographic Variables

Table 6 reveals that the nursing students' gender was significantly associated with their attitude toward AI ($p < 0.05$). Similarly, students' year of study showed a substantial association with knowledge, attitudes and perceptions of AI ($p<0.05$). On the other hand, age categories of the students did not show a significant association with their knowledge, attitudes and perceptions of AI ($p > 0.05$). Additionally, a higher proportion of female students (n=248, 88.3%) possess good knowledge of AI than their male counterparts (n=31, 86.1%). Nursing students aged 17-19 years (n=126; 90.6%) and belonging to the second year (n=70; 92.1%) were the most likely to possess sound knowledge about AI. Further, more females (n=275; 97.9%) showed a more positive attitude than males (n=30; 83.3%). Those aged 17-19 years (n = 134; 96.4%) showed more positive attitudes toward AI than those in other age categories. The fourth-year nursing students (n = 88; 94.6%) presented the most positive attitude toward AI. Regarding perception, the proportion of females with a positive perception (n = 262; 93.2%) was higher than that of males (n = 31; 86.1%). Nursing students aged 17-19 years (n = 130; 93.5%) and those in the second year (n = 70; 92.1%) perceived AI more positively than the other groups.

Table 5: Mean Domain Scores Concerning Gender, Age and Years of Study for knowledge, Attitude and Perception

Variables		Knowledge Score			Attitude Score			Perception Score		
		n	Mean±SD	p value	n	Mean±SD	p value	n	Mean±SD	p value
Gender[a]	Male	36	18.89±4.29	0.979	36	30.31±5.19	0.297	36	25.92±5.37	0.117
	Female	281	19.11±3.49		281	31.28±4.01		281	27.41±4.32	
Age	17-19	139	18.76±3.19	0.004*	139	30.75±4.18	0.001*	139	26.93±4.45	0.043*
	20 - 22	129	18.80±3.81		129	30.92±3.86		129	27.02±4.71	
	23 - 25	49	20.76±3.59		49	33.02±4.44		49	28.71±3.51	
Year of Study[b]	First Year	94	18.85±3.60	0.578	94	31.04±4.39	0.001	94	27.40±4.87	0.059
	Second Year	76	18.96±2.87		76	31.01±3.34		76	26.61±3.98	
	Third Year	42	19.05±3.83		42	28.88±5.05		42	27.24±4.36	
	Fourth Year	93	19.52±4.06		93	31.52±3.63		93	27.84±4.49	
	Internship	12	18.50±2.68		12	30.75±4.09		12	25.42±3.72	

Note: n= Number of participants, [a]Mann–Whitney U test, [b]Kruskal-Wallis Test, *Significant at p<0.05.

Table 6: Chi-square Test Displaying the Association between Age, Gender and Years of Study of Nursing Students and their Agreement Score for Knowledge, Attitude and Perception toward Artificial Intelligence

Demographical variables		Knowledge			Attitude			Perception		
		Good n (%)	Poor n (%)	Chi-Square value (p-value)	Positive n (%)	Negative n (%)	Chi-Square value (p-value)	Positive n (%)	Negative n (%)	Chi-Square value (p-value)
Gender	Male	31(86.1)	5(13.9)	0.139 (0.709)	30(83.3)	6(16.7)	18.50 (0.000) *	31(86.1)	5(13.9)	2.317 (0.128)
	Female	248(88.3)	33(11.7)		275(97.9)	6(2.1)		262(93.2)	19(6.8)	
Age	17 -19	126(90.6)	13(9.4)	4.234 (0.120)	134(96.4)	5(3.6)	3.371 (0.185)	130(93.5)	9(6.5)	2.215 (0.330)
	20 - 22	106(82.2)	23(17.8)		123(95.3)	6(4.7)		114(88.4)	15(11.6)	
	23 - 25	43(87.8)	6(12.2)		44(89.8)	5(10.2)		44(89.8)	5(10.2)	
Year of year	First Year	80(85.1)	14(14.9)	10.334 (0.035) *	88(93.6)	6(6.4)	20.279 (0.000) *	85(90.4)	9(9.6)	12.186 (0.016) *
	Second Year	70(92.1)	6(7.9)		71(93.4)	5(6.6)		70(92.1)	6(7.9)	
	Third Year	34(81.0)	8(19.0)		37(88.1)	5(11.9)		37(88.1)	5(11.9)	
	Fourth Year	79(84.9)	14(15.1)		88(94.6)	5(5.4)		82(88.2)	11(11.8)	
	Internship	7(58.4)	5(41.7)		7(58.3)	5(41.7)		7(58.3)	5(41.7)	

Note: n= Number of participants, %= percentage.

Discussion

Nursing Students' Knowledge, Attitude and Perceptions of AI

The current study examined undergraduate nursing students' knowledge, attitudes and perceptions regarding AI at selected nursing colleges in Tamil Nadu, India. Most of the participating students were female (86.6%) and ranged in age from 17 to 19 years. It is observed that over 80% of the participating students are very familiar with the term 'AI' and possess basic knowledge about its working principles (66.9%). In contrast, an earlier study conducted in an Indian nursing college revealed that most nursing students (82%) demonstrated an average knowledge about AI, with only 3% demonstrating a good understanding (20). The differences in outcomes may be attributed to the earlier study (20), which focused on a nursing student population from a single private institution. In contrast, the current study included students from various private nursing colleges, all located in a single state of India. Notably, this observed difference in the nursing students' knowledge may also be because of variations in the program design, which includes AI literacy, hands-on practice and ethical considerations-essential components for preparing students for AI-driven healthcare environments (41). Additionally, students with higher self-rated technological skills demonstrate greater readiness to embrace AI technologies; however, those who face other perceived barriers, such as inadequate computer skills, limited understanding of AI, or time constraints, also encounter difficulties accessing AI technologies (42). A more recent study reported that 58.9% of health profession students were aware of the AI tools in their field of interest and understood the barriers to implementing AI in medicine. 30.3% had previously attended online/offline AI-related courses (24). Instead, the present study detected that 74.4% of nursing students understood AI applications in their field and 69.2% were conscious of AI's boundaries. Notably, only 45.1% had already taken online or offline AI courses, highlighting the need for AI exposure among nursing students. These differences between the two studies might be due to the populations studied and the geographical regions chosen. In particular, the current study's findings may be due to nursing schools in India often facing limited resources, which can restrict the implementation of AI tools in education. Such a disparity in resources is an influential barrier to equipping students with hands-on skills and exposure to AI tools (20).

Regarding the nursing students' attitude toward AI, 76.3% agreed that AI would revolutionize the nursing field. In line with our observation, a recent study found that nursing students commonly hold supportive perceptions of AI use in their practice, with optimistic attitudes significantly influencing their motivation to adopt AI tools; however, this study was conducted in a public nursing school in the Philippines (42). Several other studies also support the notion that AI revolutionizes all areas of nursing practice, encompassing patient care, education, research, administration and policy, as well as transforming nursing processes by aiding decision-making in clinical settings, tailoring patient care programs and boosting operational efficiency (16, 19, 43). Further, this study observed that most nursing students agreed that AI should be fragment of their nursing curriculum at the undergraduate (67.2%) and postgraduate (71.3%) level, which raises the necessity for addition of AI courses into the curriculum to support nursing students in revealing the importance of AI and prepare the future workforce with AI-related skills for technology-oriented healthcare settings, thereby improving healthcare delivery and potential outcomes (44). Although AI is a valuable tool for enhancing patient outcomes and the role of nurses, it is crucial to acknowledge the ethical issues and boundaries of AI (8). Incorporating AI-aided educational tools and virtual simulations offers nursing students riveting learning experiences (45). Additionally, the current study found that about half of nursing students agreed that nurses might be replaced by AI in the future (47.6%) and that they would never make human nurses expendable (50.1%). An earlier investigation showed that nursing students are concerned about the substitution of human nurses by AI, particularly for administrative and routine duties (46). AI, however, is typically seen as a means to enhance, rather than replace, nurses'

specialized abilities, such as patient advocacy and empathy (47).

In this study, the authors uncovered that 80.8% of nursing students expressed interest in utilizing AI in their field. In line with these findings, a recent study conducted in Iraq found a positive attitude among nurses toward using AI; however, it focused on nurses' attitudes within the country's health department rather than nursing students (29). Furthermore, another study uncovered that 74.6% of Jordanian health profession students agreed that students must comprehend the ethical implications of AI (24). At the same time, this study detected that 83% of nursing students stated that they must understand the ethical implications of AI. The outcomes of the current study differ from those of the previous one (24), which was conducted with health profession students in Jordan. Moreover, the current study's findings suggest that it is vital to provide nursing students with a thorough understanding of AI ethics, equipping them to use AI effectively (48). Incorporating ethical training programs into the nursing curriculum enables nursing students to develop critical thinking, moral judgment and self-awareness of their ethical values and biases, ultimately making them more responsible and accountable in their use of AI. Such programs can boost students' confidence and reduce anxiety in using AI in healthcare environments. Policies should promote ethical AI practice, ensure patient safety and confidentiality and foster positive attitudes toward AI's potential clinical applications (49).

Regarding nursing students' perceptions of AI adoption in educational and therapeutic areas, 71.3% agreed that AI could perform better than humans, aligning with a previous study among nursing managers (27). Though the outcomes of these two studies align, their study populations differ. Furthermore, 68.7% believed that AI would bring more benefits than harm and 49.5% perceived it as cost-effective. The human element in nursing care must be preserved, despite the potential of AI. AI should therefore enhance human nursing skills rather than replace them, ensuring that patient care remains morally and compassionately sound (50, 51). Another noteworthy observation in this study is that approximately 73% of nursing students reported that AI could enhance the nursing care process and help reduce medical errors, aligning with findings from a recent study that covered nurses in Iraq's health department rather than nursing students (29). It is interesting to note that, according to a prior study, 87% of nursing students agreed that using AI in nursing could enhance their decision-making abilities (19). Additionally, the present study found that 67.8% of participants believed AI could improve nursing decision-making and 77.9% agreed that AI would be beneficial for their future careers. This difference in outcomes might be because the recent study examined the knowledge and attitudes of not only nursing students but also nurses and other HCPs in China (19). In contrast, the current study is limited to nursing students from selected private colleges in a specific state of India. Moreover, the observations of the current study may be attributed to the advantages of AI-driven tools for nursing students, which could enhance their clinical performance, decision-making and critical thinking (41). From the nursing students' perspective, AI could be beneficial to their profession, as its influence on nursing education and practice is likely to be significant. AI enhances nursing students' learning experiences by engaging them and improving nurses' clinical practice, thereby enabling them to deliver effective patient care (52).

Nursing Students' Knowledge, Attitude and Perception of AI regarding their Demographic Characteristics

Nursing students significantly varied in their mean knowledge, attitude and perception scores regarding their age categories. However, they did not differ significantly in the mean knowledge, attitude and perception scores by gender or study year. These observations revealed no disparity in knowledge, attitude, or perception level regarding AI among nursing students by sex or year of study. In contrast, past studies found substantial variations in the nursing students' mean knowledge, attitude and perception scores regarding their gender (16). Notably, male nursing students demonstrated better knowledge, attitude and perception scores than their counterparts. Those researchers conducted their study on nursing students across 10 Arab countries, whereas the present study is confined to a specific

state of an Asian country. A recent study also demonstrated that first-year students of four Croatian nursing schools presented a positive attitude toward AI in nursing (53). However, the present study covered all undergraduate nursing students at the selected private nursing colleges in Tamil Nadu, India. Notably, further research is warranted to examine the importance of sex and academic year perspectives on AI in the nursing field, using a larger sample of nursing students. Revealing variations in age, sex and study year would aid policymakers in framing and implementing appropriate strategies to improve nursing students' knowledge, attitudes and perceptions of AI, thereby enabling them to learn to use AI in their educational and clinical tasks effectively. Such efforts would also equip the forthcoming nursing workforce to align with the technological developments in healthcare.

The authors have made further attempts to examine the relationships among age, sex and study year and their agreement scores for knowledge, attitude and perception toward AI. Accordingly, this study observed that nursing students' gender was significantly associated with their attitude toward AI. Notably, a higher proportion of female nursing students demonstrated sound knowledge, showed a more positive attitude and had a more favorable perception than their male counterparts. Furthermore, the year of study was found to be significantly associated with nursing students' knowledge, attitudes and perceptions regarding AI. A higher proportion of second-year nursing students demonstrated greater knowledge and a more positive perception than their counterparts. However, fourth-year nursing students presented a higher positive attitude toward AI. These findings are supported by a recent study that found that nursing students' knowledge of AI is positively correlated with their study year, with senior students generally reporting greater digital knowledge and a more positive attitude toward AI. It was conducted with third- and fourth-year undergraduate nursing students at a Saudi nursing college (54). However, the current study covered all undergraduate students in the selected private nursing colleges in a single state of India. This study also demonstrated that the age categories of the participating students did not show a significant association with their knowledge, attitudes and perceptions regarding AI. According to a recent study (3), age may moderate the connection between performance expectancy and the drive to use AI, rather than directly determining AI knowledge. The expectations and technological experiences of older students may differ, which could impact their approach to adopting AI.

Conclusion

This study examined undergraduate nursing students' knowledge, attitudes and perceptions towards AI at selected nursing colleges in Tamil Nadu, India. Most nursing students at those colleges were aware of AI and had a fundamental knowledge of its working principles. The participating nursing students agreed that AI would revolutionize the nursing field and should be incorporated into both undergraduate and postgraduate curricula. They stated that they must know the ethical implications of AI. They also perceived that AI could improve nursing decision-making and benefit their future career. Regarding this regional population, a significant variation in nursing students' mean scores across the knowledge, attitude and perception domains was observed, specifically by age category, but not by gender or year of study. Nursing students' gender was significantly related to their attitude toward AI. The year of study of nursing students was significantly associated with knowledge, attitudes and perceptions of AI. Notably, female nursing students and those aged 17-19 years demonstrated a sound knowledge, positive attitudes and perceptions of AI. Those in the second year had the highest proportion of good knowledge and perception of AI, whereas fourth-year nursing students had the most positive attitude. The results of this study highlight nursing students' knowledge, attitudes and perceptions of AI, which are crucial to the effective use of modern technology in the nursing field to deliver better patient care. Policymakers of nursing colleges in Tamil Nadu, India, should frame and implement effective strategies to improve students' understanding and foster more positive attitudes toward AI, thereby enhancing their use of AI in nursing education and practice.

Besides, this study focuses on a narrow sample of undergraduate nursing students from selected private nursing colleges in Tamil Nadu, India. Such a specific geographic area and type of institution hinder the generalizability of the findings. Future research could include a larger sample of undergraduate, postgraduate and doctoral nursing students from both public and private colleges in Tamil Nadu or across India, allowing for comparisons of their knowledge, attitudes and perceptions regarding AI by degree level and institution type. Also, it is warranted to examine nursing students' knowledge, attitudes and perceptions of AI across urban and rural regions of various parts of India, which would aid in revealing variations in those aspects and the extent of AI exposure and technological proficiency. These efforts would eliminate institutional and socioeconomic bias in future investigations. Researchers can compare Indian nursing students' viewpoints on AI with their counterparts in other countries to identify regional gaps. Additionally, future studies could examine the factors influencing nursing students' knowledge, attitudes and perceptions of AI using regression analysis. Furthermore, the study's outcomes offer practical implications for integrating AI into nursing education in India. First, nursing students' positive attitudes and eagerness towards AI indicated their readiness for an AI-enriched, more inclusive curriculum. It is paramount to design structured learning experiences using AI tools to improve students' knowledge of nursing education. These experiences prepare them for AI-integrated clinical environments in the future. Necessary training programs on the proper use of AI would bridge the gap between existing perceptions of AI and AI competency among nursing students and help address contemporary healthcare challenges. Lastly, nursing schools in India should develop policies and guidelines for the ethical use of AI and address the technological infrastructure challenges to facilitate broader AI integration into nursing education programs.

Abbreviations

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Author Contributions

Arul Valan P: Conceptualization, Methodology, Investigation, Data curation, Writing-Reviewing and Editing, Latha S Kannan: Conceptualization, Writing-Reviewing and Editing, Arun Vijay Subbarayalu: Writing-Original Draft, Writing-Reviewing and Editing, Sivasankar Prabaharan: Writing-Original Draft, Writing-Reviewing and Editing, Eman M Gaber Hassan: Writing-Original Draft, Nahla Ali Maher Nashaat: Writing-Original Draft, Palanivel Rubavathi Marimuthu: Formal analysis, Muhil Sakthivel: Writing-Original Draft, Vinosh Kumar Purushothaman: Writing-Original Draft, Suganya Sweetlin: Investigation, Data curation, Mohanraj Kandasamy: Investigation, Mahmudul Hoque: Writing-Original Draft, Anand Pandiyarajan: Visualization, Mohammed Barkath Ali: Visualization, Balamurugan Ganesan: Writing-Original Draft.

Conflict of Interest

The authors have no conflicts of interest to declare.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declaration of Artificial Intelligence (AI) Assistance

The authors declare no use of artificial intelligence (AI) for the write-up of the manuscript. The authors take full responsibility for the content's originality, interpretation and accuracy.

Ethics Approval

All study procedures were approved by the Ethics Research Committee of the Institutional Review Board of Dr. Kumaraswami Health Center, College of Nursing. (21/9/2024). Written informed consent was obtained from all participants, who were informed that the data collected would be used for publication

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