

Perception and Ethical Awareness of Artificial Intelligence in Medicine among MBBS Students in Karaikal District

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ABSTRACT

Background

While the use of AI in the clinical environment is gaining traction, the adoption of AI in undergraduate medical education in India is still not consistent, and there is a lack of evidence regarding the perception of the utility of AI in clinical practice and ethical awareness among the same group of students.

Objective

To understand the perception and ethical awareness of Artificial Intelligence in Medicine among the MBBS students in a medical college in Karaikal district.

Methods

The cross-sectional study with a questionnaire-based design was carried out in the Vinayaka Mission's Medical College and Hospital, Karaikal, Puducherry, India, among 440 MBBS students (including compulsory rotatory medical interns, CRMI) from 11 December 2025 to 6 February 2026 using census sampling. Socio-demographic information and 23 five-point Likert-scale items across two domains – perception of AI in medicine (12 items) and ethical awareness of AI (11 items) – were collected through a structured, self-administered questionnaire. Descriptive summarisation of the data was done using mean, standard deviation and percentage agreement.

Results

The average age of the participants was 21.9 ± 2.6 years, with 52.5% female. The majority of the students (67.3%) had not undergone formal training in AI/ethics, but 78.9% had personally used AI-based tools like ChatGPT. The score for the perception domain was 3.89 ± 0.64 , with the highest score for interest in attending AI workshops (79.8%) and lowest for adequacy of college-provided information on AI (45.7%). The ethical awareness domain had a score of 3.99 ± 0.57 , with the highest being 82.0% for the possibility that inappropriate use of AI can lead to diagnostic harm and the lowest being 50.0% for curricular coverage of AI ethics. Over 70% of the students expressed their opinion in favor of the inclusion of AI ethics in the undergraduate syllabus.

Conclusion

The students in Karaikal district showed moderately favourable perception and ethical awareness of AI in medicine, yet indicated that there was a significant lack of formal curricular exposure. The results suggest that there is a need to integrate AI and AI-ethics into undergraduate medical education in a structured manner.

Keywords

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INTRODUCTION

This has led to a reevaluation of the role of AI in undergraduate medical education, its potential applications, and the ethical implications it poses for clinical practice.³ Systematic reviews of both

clinicians' and students' attitudes indicate that AI is now seen as capable of enhancing the consistency of medical images and decreasing preventable error when integrated into existing care pathways appropriately.²

While there is a general consensus that attitudes towards the potential of AI in diagnostics and administration are positive among medical students and practising doctors in India and other LMICs, awareness of the limitations and exposure to formal AI training varies widely across institutions.⁴⁻⁶ In addition to these positive attitudes, there are ethical concerns related to the use of AI in healthcare that have been increasingly documented, such as algorithmic biases, the impact on the patient-doctor relationship, unclear accountability for AI-assisted errors, and threats to data confidentiality, each with direct implications for patient safety and professional responsibility.^{7,8} While some studies have explored perception of the clinical utility and ethical awareness of medical students separately, relatively few have examined both of these attributes simultaneously in the same population, especially in smaller academic settings outside of large teaching institutions.^{9,10}

Karaikal district has not been featured in this literature before, and it is not known whether the positive attitude of students trained in this district towards the clinical promise of AI is paralleled by a positive attitude towards the ethical implications of AI, or whether there is a discrepancy between the two. This is a crucial first step to create a baseline before curricular interventions can be designed to address AI literacy and AI ethics. Thus this study was conducted to find the MBBS students' perception and ethical awareness towards the use of Artificial Intelligence in medicine and to describe the distribution of these attitudes in the two domains.

METHODS

Study Design and Setting

The study was a cross-sectional, questionnaire based study among undergraduate medical (MBBS) students of Vinayaka Mission's Medical College and Hospital, Vinayaka Mission's Research Foundation (Deemed to be University) Karaikal, Puducherry, India.

Study Duration

Data collection was conducted for eight weeks (11 December 2025 to 6 February 2026).

Study Population

The study population consisted of all the MBBS students of Second year, Third year and Final year studying at study institution and compulsory rotatory medical interns (CRMI) during the period of data collection.

Sample Size and Sampling Method: The sample size was determined by the available data.

The sampling method used was a census (universal) sampling, where all the MBBS students and interns that were available and willing to participate during the survey period were invited to respond, and no formal sample size calculation was performed since the aim of the study was to obtain the entire population of students within the survey window. The total number of students who completed the

questionnaire and included in the final analysis was 440.

Eligibility Criteria

The inclusion criteria were: (i) students of MBBS (2nd year to final year) and interns doing CRMI at the study institution, and (ii) who were willing to give informed consent to participate. Students who did not agree or who did not complete the core questionnaire items were not analyzed.

Questionnaire

The investigators prepared a structured, self-administered questionnaire and gathered data by an online form. The wording of items and categories of responses were checked internally for clarity and face validity before they were circulated. There were two parts to the instrument. Socio-demographic and background characteristics, including age, gender, year of MBBS training, home background (urban, semi-urban, or rural), previous formal learning or training about AI or AI ethics, and self-rated computer/internet literacy. The second included 23 items rated on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree) that measured two conceptually distinct areas: perception of AI's clinical utility, educational readiness, and professional impact (12 items) and ethical awareness of AI, including bias, patient autonomy, confidentiality, transparency, accountability, justice, and curricular preparedness (11 items).

Variables

The main outcome variables were the two domains, perception of AI in medicine and ethical awareness of AI in medicine, which were analysed both on an individual item level and as a composite score of the domain (mean of the item scores for each respondent). Independent/background variables were: age, gender, year of study, home background, previous AI/ethics training, personal use of AI tools, and computer/internet literacy.

Data Collection

Questionnaire link was shared with eligible students via institutional and class communication channels. Responses were anonymous except for the optional name field which was not used in analysis; there is no report of personally identifiable information in this manuscript. Respondents were only allowed to enter one response. Responses were downloaded in a password protected spreadsheet for cleaning and analysis.

Statistical Analysis

Data was cleaned and analysed using standard statistical software. Two entries were only missing the age information, with implausible or non-numeric age value, and were only excluded from age-specific analysis, but included in all other analyses because the information for the other items was complete and internally consistent. Categorical variables (gender, year of study, home background, prior training, AI tool use, computer literacy) were described using frequencies and percentages, and

descriptively cross-tabulated by year of study. For continuous variables (age, domain scores) mean $\pm$ standard deviation was used. The mean $\pm$ standard deviation and the percentages of those who agreed/strongly agreed (scores ≥ 4), were neutral (scores = 3), and disagreed/strongly disagreed (scores ≤ 2) were used to describe the 23 Likert scale items. The scores of the composite domain of perception and ethical awareness were calculated by taking the mean of the scores of items within each domain and presented descriptively. Results are displayed in tables and graphically (as a bar chart) for ease of interpretation. No inferential comparisons between subgroups were conducted; analysis was limited to descriptive statistics, as this was an exploratory, baseline-assessment study.

Ethics

The study was performed according to the ethical principles of Declaration of Helsinki. The Institutional Ethics Committee, Vinayaka Mission's Medical College and Hospital (IEC Approval No. IEC/VMMCH/2025/OCTOBER/026) approved this study. Consent was electronic and all participants were asked to provide this consent prior to accessing the questionnaire, and participation was voluntary. The responses were anonymous and confidential throughout the data collection, storage, and analysis and no identifiable data are reported in this manuscript.

RESULTS

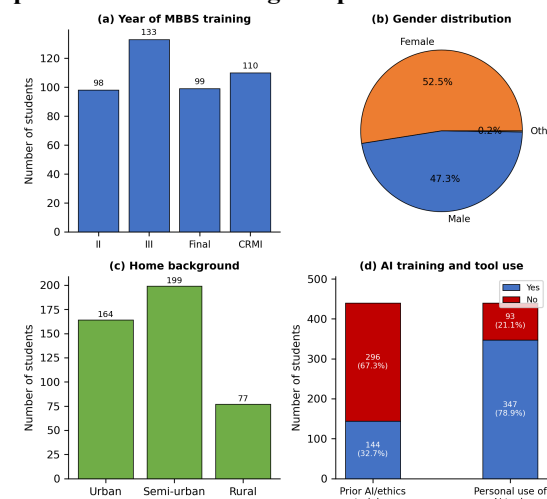
The total number of students in the study were 440 MBBS students (Table 1, Figure 1). The average age of the respondents was 21.9 ± 2.6 years (range 18 to 32 years, $n = 439$, with one implausible age being excluded from the age analysis). The female participants were slightly more than half (52.5%) and the sample ranged from Second Year to Final Year with the highest number being in the Third Year (30.2%), followed by interns (25.0%), Final Year (22.5%) and Second Year (22.3%). The home background of the students was almost equally divided; semi-urban (45.2%), urban (37.3%) and rural (17.5%). 67.3% of respondents indicated that they had never received formal education or training on AI or AI ethics, and most respondents (78.9%) had personally used AI-based tools like ChatGPT for study or for healthcare-related purposes. 81.8% of the sample rated their computer/internet literacy as good or very good, 16.8% rated their computer/internet literacy as fair, and 1.4% rated their computer/internet literacy as poor.

Table 1. Socio-demographic and Background Characteristics of Study Participants (N = 440)

Variable	Category	n	%
Age (years), mean $\pm$ SD	21.9 $\pm$ 2.6 (range 18–32; $n = 439$)	–	–
Gender	Female	231	52.5

	Male	208	47.3
	Others	1	0.2
Year of MBBS training	Second Year	98	22.3
	Third Year	133	30.2
	Final Year	99	22.5
	Interns (CRMI)	110	25.0
Home background	Urban	164	37.3
	Semi-urban	199	45.2
	Rural	77	17.5
Prior formal teaching/training on AI or AI ethics	Yes	144	32.7
	No	296	67.3
Personal use of AI-based tools (e.g., ChatGPT)	Yes	347	78.9
	No	93	21.1
Self-rated computer/internet literacy	Poor	6	1.4
	Fair	74	16.8
	Good	197	44.8
	Very good	163	37.0

Figure 1. Socio-demographic profile of study participants: (a) year of MBBS training, (b) gender distribution, (c) home background, (d) prior AI/ethics training and personal AI tool use



Perception of AI in Medicine

The item-wise distribution of the responses to the 12 statements which form the perception domain is

shown in Table 2 and Figure 2. The greatest consensus was found for the interest in attending a workshop or training on AI in medicine (79.8%, mean 4.22 ± 0.94), followed by the belief that AI should complement human physicians, rather than replace them (81.8%, mean 4.17 ± 0.86) and the desire to attend hands-on sessions or case studies on AI (76.4%, mean 4.14 ± 0.94). A majority also agreed that AI would improve diagnostic accuracy (74.5%; mean 4.03 ± 0.88) and that AI could reduce the humanistic aspects of medicine, such as empathy and the patient-physician relationship (78.9%; mean 4.02 ± 0.98). The least consensus was for the item that the medical college had provided enough information about AI in medicine (45.7% agreed, 29.5% disagreed; mean 3.30 ± 1.32), and the second was for the item that they felt confident discussing applications of AI with peers or faculty (55.9% agreed; mean 3.62 ± 1.04). The overall score for the perception domain was 3.89 ± 0.64 (range 1.0–4.92), with 58.6% of the students in the favourable range (domain mean ≥ 4), 34.5% in the moderate range ($3 < 4$) and 6.8% in the unfavourable range (< 3) (Table 4, Figure 4).

Table 2. Item-wise Responses for the Perception of AI in Medicine Domain (N = 440)

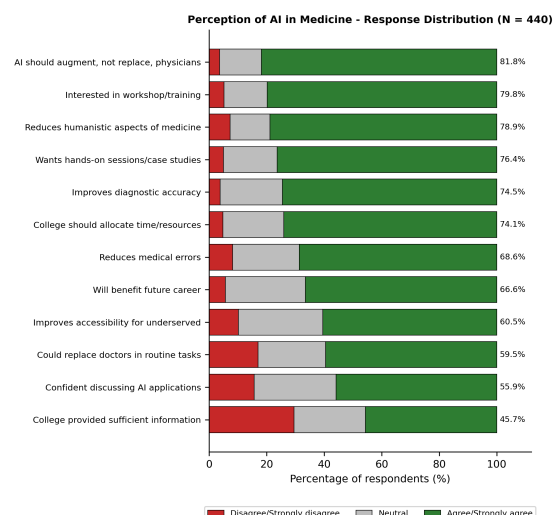
S. No	Statement	Mean $\pm$ SD	Agree/Strongly Agree n (%)	Neutral n (%)	Disagree/Strongly Disagree n (%)
1	I believe AI will improve the accuracy of medical diagnosis	4.03 ± 0.88	328 (74.5)	95 (21.6)	17 (3.9)
2	I believe AI will help reduce medical errors	3.90 ± 0.97	302 (68.6)	102 (23.2)	36 (8.2)
3	I believe AI can improve accessibility of healthcare services to underserved	3.76 ± 1.05	266 (60.5)	129 (29.3)	45 (10.2)

	populations				
4	I believe AI could replace doctors in certain routine medical tasks	3.61 ± 1.16	262 (59.5)	103 (23.4)	75 (17.0)
5	I believe AI could reduce the humanistic aspects of medicine (e.g., empathy, patient-doctor relationship)	4.02 ± 0.98	347 (78.9)	61 (13.9)	32 (7.3)
6	I am confident in discussing AI applications in medicine with fellow students or faculty	3.62 ± 1.04	246 (55.9)	125 (28.4)	69 (15.7)
7	My medical college has provided sufficient information about AI in medicine	3.30 ± 1.32	201 (45.7)	109 (24.8)	130 (29.5)
8	I am interested in attending	4.22 ± 0.94	351 (79.8)	66 (15.0)	23 (5.2)

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	a workshop/training on AI in medicine				
9	I believe AI should augment rather than replace human physicians	4.17 ± 0.86	360 (81.8)	64 (14.5)	16 (3.6)
10	I would like to attend hands-on sessions or case studies on AI in medicine	4.14 ± 0.94	336 (76.4)	82 (18.6)	22 (5.0)
11	Learning about AI in medicine will benefit my future career	3.92 ± 0.93	293 (66.6)	122 (27.7)	25 (5.7)
12	My medical college should allocate dedicated time/resources for AI/AI-ethics training	4.03 ± 0.90	326 (74.1)	93 (21.1)	21 (4.8)

Figure 2. Response distribution (Agree/Neutral/Disagree) for the 12 items of the Perception of AI in Medicine domain, ranked by percentage agreement



Ethical Awareness of AI in Medicine

Table 3 and Figure 3 show the distribution of the 11 items that make up the ethical awareness domain. There was the highest level of agreement on the statement that improper use of AI could cause under- or over-diagnosis, which could harm patients (82.0% agreement, mean 4.24 ± 0.85), followed by the statement that responsibility and accountability for decisions made by AI should be clearly defined (79.5% agreement, mean 4.14 ± 0.82) and that patient autonomy and informed consent should remain important when AI is involved in treatment decisions (81.8% agreement, mean 4.13 ± 0.89). There was strong agreement that AI systems can introduce bias and discrimination into healthcare (mean 4.12 ± 0.83 , 80.7% of respondents) and that justice and fairness in access need to be addressed when integrating AI into healthcare (mean 4.15 ± 0.87 , 79.5%). The least agreement was expressed for the statement "The medical curriculum had covered the ethical issues of AI in medicine" (50.0% agreement, 30.5% disagreement; mean 3.35 ± 1.28), and "feeling prepared to engage in the discussion about the ethical implications of AI" (55.5% agreement; mean 3.60 ± 1.16). 67.5% of participants (mean 3.95 ± 0.93) agreed that confidentiality and privacy of patient information were important concerns. Overall, the ethical awareness domain score was 3.99 ± 0.57 (range 1.0–5.0) with 61.1% of students scoring in the favourable range, 34.8% in the moderate range and 4.1% in the unfavourable range (Table 4, Figure 4).

Table 3. Item-wise Responses for the Ethical Awareness of AI Domain (N = 440)

S. No	Statement	Mean ± SD	Agree/Strongly Agree n (%)	Neutral n (%)	Disagree/Strongly Disagree n (%)
1	I am aware that AI	4.12 ± 0.83	355 (80.7)	69 (15.7)	16 (3.6)

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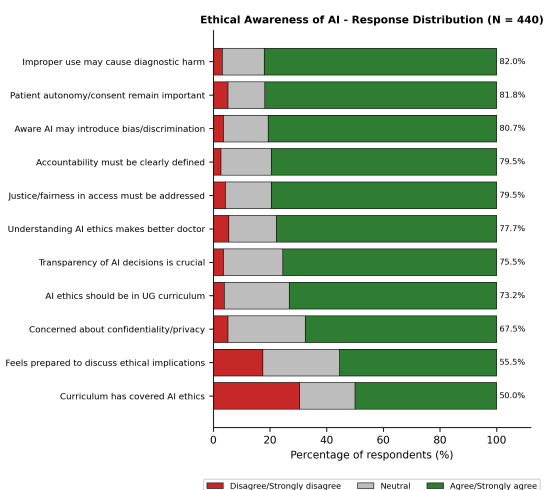
	systems may introduce bias or discrimination in healthcare	0.83			
2	I believe patient autonomy and informed consent are as important when AI is involved in treatment decisions	4.13 ± 0.89	360 (81.8)	57 (13.0)	23 (5.2)
3	I am concerned about confidentiality and privacy of patient data when AI is used in medicine	3.95 ± 0.93	297 (67.5)	120 (27.3)	23 (5.2)
4	I believe transparency (explainability) of AI decisions is crucial in	4.07 ± 0.88	332 (75.5)	92 (20.9)	16 (3.6)

	clinical settings				
5	Responsibility and accountability for AI-driven decisions in medicine must be clearly defined (who is liable?)	4.14 ± 0.82	350 (79.5)	78 (17.7)	12 (2.7)
6	Improper use of AI may lead to under-diagnoses or over-diagnoses, posing harm to patients	4.24 ± 0.85	361 (82.0)	65 (14.8)	14 (3.2)
7	Justice and fairness (equal access) must be addressed when integrating AI in healthcare	4.15 ± 0.87	350 (79.5)	71 (16.1)	19 (4.3)
8	My medical curriculum has covered the ethical issues of AI in	3.35 ± 1.28	220 (50.0)	86 (19.5)	134 (30.5)

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	medicin e				
9	I feel prepared to engage in discussions about ethical implications of AI in medicine	3.60 ± 1.16	244 (55.5)	119 (27.0)	77 (17.5)
10	AI and its ethical implications should be integrated into the undergraduate medical curriculum	4.05 ± 0.89	322 (73.2)	101 (23.0)	17 (3.9)
11	Understanding AI and its ethical issues will make me a better doctor	4.12 ± 0.92	342 (77.7)	74 (16.8)	24 (5.5)

Figure 3. Response distribution (Agree/Neutral/Disagree) for the 11 items of the Ethical Awareness of AI domain, ranked by percentage agreement



Comparative Domain Summary

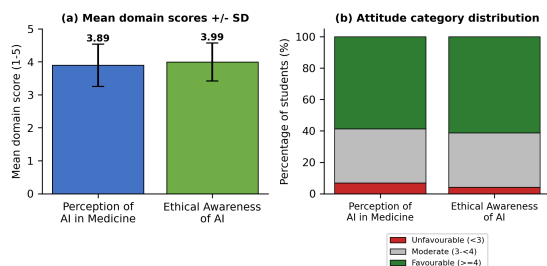
The ethical awareness domain had a slightly higher mean score and higher percentage of students in the favourable category than the perception domain as summarised in table 4 and figure 4. In both domains, the lowest agreement item was related to curricular exposure (perception of how much information was provided by the college, and curricular coverage of ethical issues), while the items that reflected interest in further training, workshops and curriculum integration were consistently among the highest-scoring items across both domains (79.8% interest in workshops; 74.1% support for dedicated institutional time/resources; 73.2% support for curriculum integration of AI ethics).

Table 4. Summary of Perception and Ethical Awareness Domain Scores (N = 440)

Domain	No. of items	Mean ± SD	Favourable (≥4) (%)	Moderate (3-4) (%)	Unfavourable (<3) (%)
Perception of AI in Medicine	12	3.89 ± 0.64	258 (58.6)	152 (34.5)	30 (6.8)
Ethical Awareness of AI	11	3.99 ± 0.57	269 (61.1)	153 (34.8)	18 (4.1)

Figure 4. (a) Mean domain scores with standard deviation; (b) distribution of students by favourable, moderate, and unfavourable attitude category for each domain

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Highest- and Lowest-Rated Statements Across Domains

Table 5 lists the top five most and least endorsed statements for all 23 items, regardless of the domain. The 5 highest rated statements were from both domains and focused on perceived harm from improper use of AI, the importance of physician oversight, patient autonomy, awareness of algorithmic bias, and desire for more training. All five bottom-rated statements were related to either curricular exposure (adequacy of information provided by the college, curricular coverage of AI ethics) or self-rated confidence and preparedness to discuss AI and ethical implications of AI or the belief that AI may replace doctors in routine tasks.

Table 5. Highest- and Lowest-Rated Statements Across Both Domains (N = 440)

Rank	Statement	Domain	Mean $\pm$ SD	Agree/Strongly Agree (%)
Highest-rated statements				
1	Improper use of AI may lead to under-diagnosis or over-diagnosis, posing harm to patients	Ethics	4.24 $\pm$ 0.85	82.0
2	I believe AI should augment rather than replace human physicians	Perception	4.17 $\pm$ 0.86	81.8
3	I believe patient autonomy and informed consent are as important when AI is	Ethics	4.13 $\pm$ 0.89	81.8

	involved in treatment decisions			
4	I am aware that AI systems may introduce bias or discrimination in healthcare	Ethics	4.12 $\pm$ 0.83	80.7
5	I am interested in attending a workshop/training on AI in medicine	Perception	4.22 $\pm$ 0.94	79.8
Lowest-rated statements				
19	I believe AI could replace doctors in certain routine medical tasks	Perception	3.61 $\pm$ 1.16	59.5
20	I am confident in discussing AI applications in medicine with fellow students or faculty	Perception	3.62 $\pm$ 1.04	55.9
21	I feel prepared to engage in discussions about ethical implications of AI in medicine	Ethics	3.60 $\pm$ 1.16	55.5
22	My medical curriculum has covered the ethical issues of AI in medicine	Ethics	3.35 $\pm$ 1.28	50.0

23	My medical college has provided sufficient information about AI in medicine	Perception	3.30 ± 1.32	45.7
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AI Training and Tool Use by Year of MBBS Training

Prior training in AI/ethics and use of personal AI tools by year of MBBS training are shown in Table 6. Prior formal training reported by students varied from 24.5% (Second Year) to 39.4% (Final Year) and did not show any consistent trend across the successive years. The use of AI-based tools for personal use varied from 67.7% (Third Year) to 91.8% (interns undergoing CRMI) and was the highest in numbers for interns in all groups.

Table 6. Prior AI/Ethics Training and Personal AI Tool Use by Year of MBBS Training (N = 440)

Year of MBBS	N	Prior AI/Ethics Training — Yes n (%)	Personal AI Tool Use — Yes n (%)
Second Year	98	24 (24.5)	75 (76.5)
Third Year	133	49 (36.8)	90 (67.7)
Final Year	99	39 (39.4)	81 (81.8)
Interns (CRMI)	110	32 (29.1)	101 (91.8)
Total	440	144 (32.7)	347 (78.9)

DISCUSSION

The present cross-sectional study of 440 MBBS students in Karaikal district revealed that the perception of clinical utility of AI was moderately favourable (3.89 ± 0.64 on 5-point scale) and the ethical awareness of AI implications were also moderately favourable (3.99 ± 0.57 on 5-point scale). In our cohort, ethical awareness was slightly higher than the perception of clinical utility, which is not always found in the literature, where the excitement for the diagnostic potential of AI has at times been reported to be greater than the explicit engagement with the ethical aspects.^{9,10}

The result of 74.5% agreeing that AI would increase the accuracy of diagnosis and 68.6% agreeing that AI would reduce medical errors was consistent with the general positive attitude towards the role of AI in diagnosis among medical students and doctors in India.^{4,11} There was slightly less agreement that AI would increase access to care for underserved populations (60.5%) and that AI could replace doctors in routine tasks (59.5%). This relative caution in the overall belief in the full task delegation of AI, despite the overall positive view of the technical capability of AI, was further highlighted in our data by the 81.8% agreement that AI should be used to assist rather than replace physicians, suggesting that most students in Karaikal district view AI as a supervised, physician-led model of care rather than an autonomous decision-maker.^{7,12}

One trend in our perception items was that there was a disconnect between positive perceptions of AI and confidence in interacting with it, as only 55.9% of students felt confident discussing AI applications with peers or faculty, and only 45.7% agreed that their college had provided enough information about AI in medicine (with 29.5% actively disagreeing). This curriculum-exposure gap was not limited to the junior students, as the interns (CRMI) (representing one-quarter of the sample), who are the closest to independent clinical practice, did not report significantly more prior formal exposure than earlier year students (range 24.5–39.4%), indicating that formal exposure to AI concepts may be limited across, rather than at or incrementally developed during, a specific year of the MBBS program in this context.

Items related to patient-facing risks had consistently high levels of agreement: 82.0% of students agreed that inappropriate use of AI could result in under- or over-diagnosis, 81.8% agreed that patient autonomy and informed consent are still paramount when treating a patient with AI, and 80.7% agreed that AI systems could introduce bias or discrimination into healthcare delivery. Ethical awareness around algorithmic bias and the importance of maintaining informed consent are comparable among medical students in other regions in cross-sectional surveys with an ethics focus, suggesting that awareness of

potential harms associated with AI may be spreading even in the absence of specific AI teaching, perhaps through informal encounters with AI tools, general media attention, or existing bioethics teaching.^{8,14} Even with this awareness, only 50.0% of students indicated that their curriculum had covered the ethical implications of AI in medicine, and only 55.5% felt they were prepared to discuss these implications, the two lowest scoring items in the ethics domain, which closely match the gap in the perception domain (Table 5). These two together are the most educationally actionable finding of this study: MBBS students of the Karaikal district seem to have fairly good intuitive sense of both the promise and the risk of AI in medicine, but largely without any structured curricular support, and they are aware of this. The readiness-preparedness gap, as described in similar cohorts of undergraduate students, is a similar disconnect between interest in AI and self-perceived readiness to apply it.¹⁵

Despite the near-total lack of formal training reported by two-thirds of the sample (67.3% reported no prior formal teaching on AI or AI ethics), nearly all of our respondents (73.2%) agreed that AI ethics should be integrated into the undergraduate curriculum, while 74.1% agreed that there should be dedicated institutional time or resources for AI/AI-ethics training; of note, personal use of AI tools such as ChatGPT was highest among interns (91.8%, Table 6). This indicates that informal, unsupervised interaction with AI is outpacing institutional guidance in this context, which has governance implications as students who interact with clinical AI tools without ethical guidance might develop assumptions or habits that are hard to change later in their training.

The comparatively low endorsement for the need to address confidentiality and privacy of patient data when implementing AI in healthcare (67.5%) could be due to lower exposure to data-intensive AI tools during undergraduate medical education or a lack of discussion of health-data governance in the current curriculum, which is a salient theme in knowledge and attitude/practice surveys of medical students and doctors in other health systems.^{6,19,20}

From a clinical perspective, this indicates that the MBBS students in Karaikal district are developing a certain critical realism towards AI—both appreciating its diagnostic capabilities and rejecting the possibility of uncritical delegation of clinical authority—that should be intentionally cultivated through training rather than left to occur naturally. Without structured ethics training, positive attitudes towards AI support can lead to a generation of doctors who are technologically advanced but lacking in the knowledge and skills to address liability, informed consent, or algorithmic bias in clinical settings. Educationally, our findings align with the recent recommendations from scoping and systematic reviews of AI in medical education,

which suggest that AI and its ethical implications should be integrated into current educational modules like bioethics, community medicine, or clinical skills training, instead of being an add-on or elective.^{2,3,16}

There are strengths of this study. To the best of our knowledge, it is one of the first to evaluate the perception of clinical utility and ethical awareness of AI together and not as separate entities among the MBBS students in the Karaikal district with a comparatively large sample size covering all years of undergraduate training including interns. Selection bias is minimized by the census-based recruitment strategy, which enrolled all accessible and consenting students during the study period, as opposed to a convenience subset of students.

Some caveats should be noted, as well. The cross-sectional, self-reported design was not suitable to draw conclusions about causality and to account for the development of attitudes as a function of increasing clinical exposure, and socially desirable response may have led to higher levels of agreement with ethically positive statements. The study was carried out in a single institution, and the generalisability of the findings to students from other institutions with different curricular structures or varying levels of exposure to AI in the institution is restricted. The questionnaire did not use a psychometrically validated instrument specific to AI ethics in the Indian undergraduate context and the domain scores obtained from simple item averaging might not fully capture the multidimensional nature of perception and ethical awareness as precisely as a factor-analytically validated instrument would. The survey was conducted online so students with limited access to computers and internet may have been under-represented, but the high self-rated computer and internet skills of our sample (81.8% combined) suggests that this effect was likely not great.

Future studies should aim to validate the instrument for knowledge and attitude of AI-ethics for undergraduate medical education in India, understand the change in perception and ethical reasoning over a period of time from pre-clinical to clinical and internship years, and understand the impact of structured curricular interventions on both the constructs measured in this study. Comparing the exposure to the curriculum in Karaikal district with other districts or institutions with greater urbanization or resources would help to understand if the observed gap is a local issue or a more generalized issue in undergraduate medical education in India.

CONCLUSION

The study concluded that the perception of the clinical usefulness of AI and awareness of its ethical implications among the MBBS students in the Karaikal district were moderately favourable, with the latter being slightly higher overall. Yet, less than

half of the students felt their curriculum had sufficiently covered AI or the ethical aspects of AI, and less than half of them felt confident in talking about AI in an academic setting. This curriculum-exposure gap, which was consistent across both domains, as well as the strong student support for structured training suggests that current favourable attitudes have emerged more out of the curriculum than out of formal instruction. Incorporation of AI literacy and AI ethics into the undergraduate medical curriculum should be deliberate rather than incidental or elective, to ensure positive attitudes are accompanied by the competence needed to apply AI responsibly in clinical practice.

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