RESEARCH ARTICLE

Beyond knowledge: How metacognitive awareness shapes clinical judgment in final-year medical students

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Abstract

Objective: To determine the correlation between metacognition and clinical reasoning among final-year medical students.

Method: The cross-sectional, correlational study was conducted from June to August 2022 at two medical colleges (one public and one private) in Islamabad, Pakistan, after approval from the ethics review boards of Shifa Tameer-e-Millat University, Islamabad, and the Federal Medical Teaching Institute, Islamabad. All final-year medical students at the two institutions were included, and data was collected using structured questionnaires based on metacognitive awareness and diagnostic thinking tools. Data was analysed using SPSS 25.

Results: Of the 200 students, 110(55%) were females, 90(45%) were males, 85(42.5%) were aged 23 years, 107(53.5%) were day scholars, 93(46.5%) were living in hostels, and 100(50%) belonged to each of the two participating institutions. A positive linear relationship was found between metacognitive awareness and diagnostic thinking (R2=0.07). Moderate correlations were found between declarative (rho=0.197), conditional (rho=0.064) and procedural knowledge (rho=0.177); comprehension monitoring (rho=0.193); debugging strategies (rho=0.209); and evaluation subscale (rho=0.211). The diagnostic thinking score of private medical college was significantly higher than public medical college ($p<0.05$), while debugging strategies and evaluation score of public medical college were significantly higher than private medical college ($p<0.05$). Memory structure, declarative knowledge and information of males, while conditional knowledge of female medical students were significantly high ($p<0.05$).

Conclusion: There was a positive linear relationship between metacognitive awareness and diagnostic thinking among medical students. Overcoming learning challenges, mentoring support, student-oriented teaching, and learning and providing effective clinical exposure can improve clinical reasoning.

Keywords: Metacognition, Clinical reasoning, Medical student. (JPMA 76: 877; 2026)

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Introduction

Metacognitive awareness and clinical reasoning (CR) skills are essential for medical students to become good doctors in the future.[1] It is imperative that medical students acquire proficient clinical reasoning skills prior to commencing independent practice as physicians.[2] The ability to think critically in an unpredictable and challenging healthcare environment is a crucial skill required for medical students to transition into clinical practitioners. Metacognitive awareness serves as a means of instructing the cognitive systems necessary for CR skills that also referred as diagnostic thinking.[3] CR skills are strongly linked to the delivery of optimal patient care services. Therefore, medical students are often assessed based on their CR skills during their clinical years.[4] Medical students find it very challenging to learn CR skills.[5] Metacognitive skills are widely acknowledged as essential for the improvement of CR as metacognitive control or regulation of cognitive skills. Metacognitive awareness includes both knowledge of cognition and regulation of cognition.[6]

Metacognition increases the ability to plan and judge cognitive processes that help medical students and teachers develop purposeful and relevant thinking for difficult and complex problems in clinical practice. Students are required to integrate, classify and organise medical knowledge for practical use. With metacognition, students can successfully identify gaps in knowledge, and can adjust their cognitive strategies by using the cyclical process of pattern recognition, formative feedback[7] and theoretical cues.[3] Development of CR skills involves the mobilisation and application of knowledge and experience while facing a clinical problem.[2] These include tasks like history-taking and physical examination of patients[8] and formulating management plans.[9]

Medical education emphasises that clinical educators should shift cognitive skills from academic to clinical settings.[10] However, lack of competent and experienced

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medical teachers, and inability to shift knowledge and skill to patient care effectively are barriers.[3] Furthermore, assessment of CR is challenging because it must be figured out from behaviour.[11]

It has been further asserted that students with poor CR skills feel anxious about making clinical decisions and the likelihood of diagnostic errors rises in such cases.[12] These diagnostic errors cause great harm to patients.[13] CR failures are a significant cause of patient morbidity and mortality. It results in about 40,000 deaths each year, and is also a cause of 28.6% of malpractice claims in the United States.[6] These errors usually occur due to unpredictable situations, difficult cases or time constraints.[6]

CR forms a connection between medical knowledge and clinical practice.[14] CR skills are key to medical competence, and are an essential domain required to become a good physician.[5] Educators can improve CR among undergraduate medical students by increasing their metacognitive awareness and by enabling them to self-evaluate themselves on their theoretical and practical methods.[10]

Literature review indicates that most studies have examined either CR or metacognition within single settings and through cross-sectional survey designs.[1,2,5-7] Therefore, further research employing more robust correlation and cohort designs is warranted to strengthen evidence in this area.

An appropriate theoretical framework is the dual-process theory, which integrates the main processes in the field of CR. The theory states that humans have two thinking systems. System-1 is unconscious and fast, and uses shortcuts. It is a bit sloppy, but is mostly relied upon. System-2 is conscious, calculated and more accurate, but it is slow.[15]

There is a need to highlight the role of metacognitive awareness, often experienced as intuitive insight, in shaping CR and supporting decision-making in medical practice. The current study was planned to determine the correlation between metacognition awareness and CR among final-year medical students.

Subjects and Methods

The cross-sectional, correlational study was conducted from June to August 2022 at two medical colleges (one public and one private) in Islamabad, Pakistan, after approval from the ethics review boards of Shifa Tameer-e-Millat University, Islamabad, and the Federal Medical Teaching Institute, Islamabad. All final-year medical students at the two institutions were included. Medical students who had migrated from other medical colleges and/or repeaters were excluded. Final-year medical students from both medical colleges were invited to participate using census sampling technique, which was done to eliminate sampling errors and to provide data on all persons in the population.[16] The students were contacted during face-to-face interactions. A packet comprising informed consent form and questionnaires was handed over to the students, and they were asked to fill up the questionnaires and hand them over to the medical education secretary the following day. The principal researcher collected the questionnaires from the medical education secretary on subsequent days. Two data collection tools were used. The Schraw and Dennison Metacognitive Awareness Inventory has 52 questions divided into two primary parts. The initial segment is about "*Knowledge about cognition*" (17 questions) which has three subdomains, namely: "*declarative knowledge*" (8 questions), "*procedural knowledge*" (4 questions), and "*conditional knowledge*" (5 questions). The subsequent part is about "*Regulation of cognition*" (35 questions) having five subdomains; "*planning*" (7 questions), "*information management strategies*" (9 questions), "*comprehension monitoring*" (8 questions), "*debugging strategies*" (5 questions), and "*evaluation*" (6 questions). Every correct answer was scored 1, and incorrect answer was scored 0. The reliability of the tool was assessed using Cronbach's alpha, which was 0.89.[17]

The other tool was the Diagnostic Thinking Inventory, which is a self-report questionnaire based on CR and medical diagnostics. The inventory has 41 questions, representing two dimensions: "flexibility in thinking" and "evidence for structure in memory". There were 21 questions related to the former, and 20 related to the latter. Each question has a stem with two accompanying statements and a rating scale. The scale refers to the spectrum between two extreme statements.18 Items 2-6, 11, 15, 16, 23, 24, 26-28, 30, 32, 34, 35, 36, 38, 40 and 41 measure "*flexibility of thinking*", and their maximum score is 126. Items 1, 7-10, 12, 13, 14, 17-19, 20-22, 25, 29, 31, 33, 37 and 39 are related to the "*structure of memory*", and their maximum score is 120.[5] The internal consistency was good for the overall score of the inventory with Cronbach's alpha value being 0.84.[18]

The data was coded and analysed using SPSS 25. Demographic variables were reported as frequencies and percentages. Data normality was tested using the Shapiro-Wilk test. Metacognitive awareness and CR were reported as median with interquartile range (IQR). The correlation between metacognitive awareness and CR was measured using Spearman's correlation test. A linear regression analysis was performed between metacognitive awareness and CR. Difference between study settings (public, private) and gender (male, female) was determined using the Mann-Whitney U-test. P<0.05 was considered significant.

Results

Of the 200 students, 110(55%) were females, 90(45%) were males, 85(42.5%) were aged 23 years, 107(53.5%) were day scholars, 93(46.5%) were living in hostels, and 100(50%) belonged to each of the two participating institutions (Table 1).

The flexibility of thinking had a moderate positive correlation with information (rho=0.225), comprehension monitoring (rho=0.193) and evaluation (rho=0.211). Evaluation, which is a component of regulation of cognition, had a moderate positive correlation with declarative knowledge (rho=0.103), procedural knowledge (rho=0.102) and planning (rho=0.122). Memory structure had a low positive correlation with declarative knowledge (rho=0.197), procedural knowledge (rho=0.177) and planning (rho=0.164). Memory structure had a moderate correlation with information (rho=0.192), comprehension monitoring (rho=0.188), debugging strategies (rho=0.209) and evaluation (rho=0.241) (Table 2).

The diagnostic thinking score of private medical college was significantly higher than public medical college (p<0.05), while debugging strategies and evaluation score of public medical college were significantly higher than private medical college (*p*<0.05) (Table 3).

In terms of gender, memory structure, declarative knowledge and information of males, while conditional knowledge of female medical students were significantly high (*p*<0.05) (Table 4).

Table-1: Demographic characteristics (n=200).

Variables	n (%)
Gender	
Male	90 (45.0)
Female	110 (55.0)
Age (years)	
22	68 (34.0)
23	85 (42.5)
24	47 (23.5)
Colleges	
College A (Public)	100 (50.0)
College B (Private)	100 (50.0)
Residence	
Hostel	93 (46.5)
Home	107 (53.5)

Table-2: Correlation of diagnostic thinking with metacognitive awareness.

Metacognitive awareness subscales	Diagnostic Thinking			
	Flexibility of Thinking		Structure of Memory	
	rho	95% CI [lower, upper]	rho	95% CI [lower, upper]
Declarative Knowledge	0.103	-0.036, 0.24	0.197**	0.06, 0.330
Procedural Knowledge	0.102	-0.037, 0.24	0.177*	0.039, 0.310
Conditional Knowledge	-0.002	-0.14, 0.14	0.064	-0.075, 0.200
Planning	0.122	-0.017, 0.26	0.164*	0.026, 0.300
Information	0.225**	0.089, 0.35	0.192**	0.055, 0.320
Comprehension Monitoring	0.193**	0.056, 0.32	0.188**	0.051, 0.320
Debugging Strategies	0.093	-0.046, 0.23	0.209**	0.072, 0.340
Evaluation	0.211**	0.074, 0.34	0.241**	0.11, 0.370

Correlation is significant at the 0.01 level (2-tailed); rho= Spearman's correlation coefficient, p=statistical significance. CI: Confidence interval.

Table-3: Comparison of metacognitive awareness and diagnostic thinking between the participating colleges.

Diagnostic thinking and metacognitive awareness subscales	Public College		Private College		U-test
	Median	Interquartile Range	Median	Interquartile Range	*p*- value
Diagnostic Thinking					
Flexibility of Thinking	69.0	10.8	73.0	12.8	0.002*
Structure of Memory	67.0	12.0	71.5	16.5	0.001*
Meta-Cognitive Awareness					
Declarative Knowledge	5.0	3.0	6.0	2.0	0.244
Procedural Knowledge	3.0	1.0	3.0	2.0	0.743
Conditional Knowledge	4.0	2.0	4.0	2.0	0.692
Planning	4.5	2.0	4.5	1.0	0.606
Information	5.0	2.0	6.0	1.0	0.091
Comprehension Monitoring	5.0	2.0	5.0	2.0	0.113
Debugging Strategies	4.0	1.0	4.0	2.0	0.018*
Evaluation	4.0	1.8	4.0	2.0	0.012*

**p*-value significance < 0.05

Table-4: Comparison of metacognitive awareness and diagnostic thinking across gender.

Diagnostic thinking and metacognitive awareness	Male		Female		U-test
	Median	Interquartile Range	Median	Interquartile Range	p-value
Diagnostic thinking					
Flexibility of Thinking	71.0	13.3	71.0	11.3	0.738
Structure of Memory	71.0	13.3	67.0	13.5	0.044*
Metacognitive Awareness					
Declarative Knowledge	6.0	2.0	5.0	3.0	0.028*
Procedural Knowledge	3.0	2.0	3.0	2.0	0.696
Conditional Knowledge	4.0	2.0	4.0	1.3	0.040*
Planning	4.0	2.3	5.0	1.0	0.792
Information	6.0	2.0	5.0	2.0	0.021*
Comprehension Monitoring	5.0	2.3	5.0	2.0	0.703
Debugging Strategies	4.0	2.0	4.0	2.0	0.147
Evaluation	4.0	2.0	4.0	2.0	0.288

**p*-value significance < 0.05

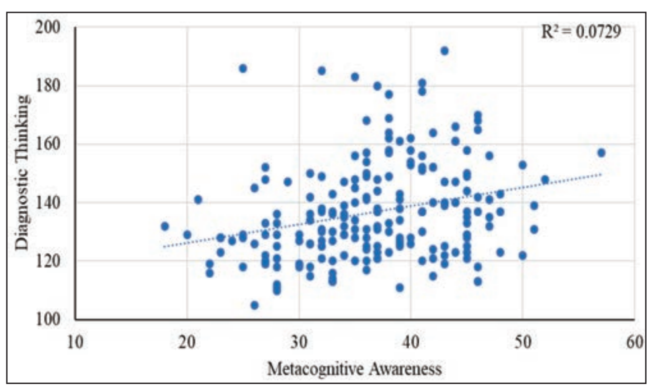

Figure: Correlation of metacognitive awareness with diagnostic thinking.

Regression analysis showed a positive linear relationship (R^2=0.07) between metacognitive awareness and CR among medical students with 95% confidence interval (CI). The model partially predicted the linearity of the relationship owing to outlier values outside the 95% CI, and the data was not normally distributed (Figure).

Discussion

The metacognition and CR scores of medical students in the current study were good, but approximately borderline. A study conducted among medical students in Lahore reported higher metacognition scores.[1] A noteworthy measurement instrument focusses on reading metacognition. In the present study, metacognition was measured as the cognitive ability to appreciate, apply, plan, monitor and evaluate knowledge. Therefore, the difference may be attributed to the varying measures of metacognition. Another Turkish[12] study among nursing students reported higher metacognitive scores. Discipline and contextual differences may be attributed to varying levels of metacognition among students. Furthermore, the diagnostic thinking scores of Saudi medical students[5] were higher than those of the current sample.

The present study evaluated different facets of knowledge, like declarative, procedural and conditional knowledge. Medical students rated themselves very high on declarative knowledge, but low on procedural and conditional knowledge. A similar pattern was reported in a study of German medical students. However, their level of declarative knowledge was higher than that of the medical students in the present study.[19] Basically, preclinical years focus on students' cognitive development. As medical students progress to their clinical years, they must use their knowledge in real-life situations. This finding is consistent with that of a qualitative study of medical students who expressed unpreparedness for clinical practice due to information overload and the reality gap.[20] Perhaps information overload contributes to the development of factual knowledge. However, conditional knowledge develops when students are exposed to various clinical situations. An Austrian study among medical students reported that the effectiveness of case-based learning (CBL) and objectively structured clinical exam (OSCE) activities helped them transform declarative knowledge into procedural knowledge.[21] This might help them apply their knowledge and improve their diagnostic thinking and metacognition. Diverse case studies are important for flexibility in thinking, which is a facet of diagnostic thinking.

Procedural knowledge was rated the lowest among the medical students in the current study. German medical students' procedural knowledge was also low because of their greater focus on declarative knowledge. Therefore, the application of knowledge is problematic.[19] Procedural knowledge is important for medical students' diagnostic competence. Scaffolding complemented by a higher level of guidance can be useful for beginner-level medical students.[22] It is noteworthy that most of the challenges were expressed by students at public-sector medical college, as determined by their low diagnostic thinking scores. However, the diagnostic thinking scores of private-sector medical college students were significantly higher. Perhaps private medical colleges have sufficient learning resources which contribute to their higher scores. However, the debugging strategies and evaluation scores of public-sector medical college students were significantly higher. The students expressed the need for formative assessment so that they could be better when assessed regularly.

The findings revealed a positive linear relationship between diagnostic thinking and metacognition. However, the correlation was low which was evident due to variations in diagnostic thinking and metacognition of medical students in the present study. As students grew in knowledge, application of knowledge, and clinical practice, their diagnostic thinking skills improved. This study found a moderate linear relationship involving procedural, declarative and conditional knowledge. Procedural knowledge depends on both conditional and declarative knowledge. Declarative and conditional knowledge lay the foundation for procedural knowledge. A scaffolding process may begin with developing declarative knowledge following implementation using conditional knowledge approaches and moving into procedural knowledge which is expected in real-life clinical situations. Scaffolding with higher guidance for beginners and lower guidance for advanced learners is suggested.[22] This study also revealed higher declarative knowledge of male medical students. This finding is further supported by the higher scores of male medical students in the information cognition and structure of memory subscales. However, the conditional knowledge scores of female medical students were higher. Female medical students might use a non-intuitive thinking pathway which facilitates knowledge application. Case-based teaching is an effective strategy for improving CR skills among medical students and health professionals.[10] The early introduction of problem-based learning (PBL) approach to undergraduates help in fostering CR skills.[23]

The current study has a few limitations. The faculty's perspective on diagnostic thinking and metacognition could not be investigated. One limitation is that CR was evaluated through self-reporting even though it is primarily inferred from observable behaviours. Despite the limitations, however, the study provides useful information to medical teachers, educational managements and medical students regarding the challenging and facilitative factors related to the development of CR and metacognition.

Conclusion

A positive linear relationship was observed between CR and metacognitive awareness among medical students. Those with flexible memory structures were more likely to use non-intuitive thinking pathways. Declarative, conditional and procedural knowledge were found to be interdependent. During their clinical years, medical students are expected to employ more conditional and procedural knowledge that is essential for CR. However, learning challenges hinder the learning and clinical reasoning processes. Addressing these challenges can enhance medical education by focusing on CR.

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Author Contribution:

GMJB: Concept, design, literature search, data collection, analysis, interpretation, writing and proofreading.

AJP: Data analysis, interpretation, critical revision and final approval.

GV: Data analysis, interpretation and proofreading.

SK: Data analysis, drafting and critical revision.