# An age and gender-based analysis of 'Metacognitive Awareness Inventory' (MCAI) among first-year MBBS students from a Central Indian medical college

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## Abstract
**Introduction:** Cognition includes all mental processes and abilities which help to generate new knowledge through activities like memory, attention, reasoning, learning, and solving problems. Meta-cognition is a subdivision of cognition. It is an awareness and understanding of one's own cognitive process.
**Materials and Methods:** This cross-sectional pre-sensitized study was done among first-year medical students of a medical college in central India. Out of 150 students, 127 participants provided valid information. 'Meta-cognitive awareness inventory' consisting of 52 questions was used. Data analysis was done by SPSS version 20 and 'P' value was set at <0.05.
**Result:** The sample was subjected to one-sample t-test. Both the dependant variables i.e. age and gender of the participants demonstrated a highly significant association ($p < 0.000$) with all scales and subscales of metacognitive awareness inventory whose above all Cronhbach's $\alpha$ was 0.752. Younger participants and females both recorded significantly higher meta-cognition skills ($p< 0.000$).
**Conclusion**: Students of less than 20 years of age and from female sex were found to have a stronger association with the cognitive process on meta-cognitive awareness inventory scale, which enables one's ability for evaluation of critical thinking, learning skills, goal settings, assessment of learning strategies and performance errors.

**Keywords**: Metacognitive awareness inventory, Age, Gender, Medical students.

## Introduction
Learning in the lay term is defined as "the process of acquiring knowledge and skills" whereas its scientific counterpart is known as 'Cognition' which means "an awareness and understanding of one's own thought processes". Meta-cognition is a form of cognition which includes active control over one's faculties in understanding and manipulation of cognitive skills.[1] Some cognitive processes are carried out consciously and deliberately, while others are carried out unconsciously and automatically.[2] Meta-cognition facilitates learners to check their own progress and direct their learning as they read and write.[3] The practice of metacognition has been shown to improve academics and a wide range of extracurricular activities. Various studies have shown that a student with higher meta-cognitive score and practice of meta-cognition performs better in their studies.[4]

For the first time, A.L. Brown (1987) proposed a model in which meta-cognition had two components; namely Knowledge about Cognition and Regulation of Cognition. Knowledge about cognition describes the knowledge of one's own cognitive capabilities, it is essential for developing conceptual knowledge, and the regulation of cognition describes the ability to monitor and control one's own cognitive process, which helps in awareness of the implementation of strategies and to check the helpfulness of strategies.[5]

Development of meta-cognition starts from early childhood and develops throughout one's life course though at a different pace. Becoming a good doctor is not a one-time learning process; instead requires continuous and persistent efforts. Thus they have to learn by facing new tasks every day in their professional life. Medical students must prepare themselves to cope with the evolving uncertainties and changes for which a sharp intellect is a much-required pre-requisite.

Various inventories have been set to assess meta-cognition. Some of the important ones are Meta-cognitive Awareness of Reading Strategy Inventory MARSI,[6] Meta-cognitive Awareness Guidance (MCAG),[7] Meta-cognitive Awareness Inventory for Teachers (MAIT),[8] Meta-cognitive Skills Inventory (MSI),[9] Meta-cognitive Awareness Inventory (MCAI).[10] From all these MCAI was used because it covers all the aspects of meta-cognition in its subdivisions and is being used across the globe and have good internal consistency (Cronbach's $\alpha = 0.90$) and inter-correlation $r = 0.54$.[17]

### Hypothesis
Review of scientific literature points at the probability of a significant difference in meta-cognitive score in line of age and gender. The present hypothesis was designed to test this in first-year MBBS students.

### Aim
To study different learning skills in first-year MBBS students in the line of sex and age category.

### Objectives
1. To estimate total meta-cognitive function inventory scores and its subscales for the participants.
2. To compare them across age and gender for the existence of visible differences.

3. To draw a conclusion and draw recommendations based on study results.

## Materials and Methods

This cross-sectional study was conducted among first-year MBBS students in the second term in a medical college from the central Indian state of Madhya Pradesh from March to June-2019.

Meta-cognitive awareness inventory (MCAI) was the tool used for this purpose. This consisted of two major divisions; knowledge about cognition and regulation of cognition. Knowledge about cognition had sub-divisions as declarative knowledge, procedural knowledge and conditional knowledge whereas Regulation of Cognition had subscales like Information management strategies, Debugging Strategies, Planning, Comprehensive Monitoring, and Evaluation.

Declarative knowledge is the knowledge which the students need for critical thinking and for the commencement of any process related to any topic. Procedural knowledge is the knowledge about how to implement methods for the completion of any procedure. Conditional knowledge is knowledge about when and how to use procedures.

Information management strategy is the gaining of skills and strategies more efficiently. Debugging strategies are the ability to correct comprehension and performance error. Planning under the regulation of cognition relates to goal setting and prioritizing things before learning. Comprehension monitoring is the assessment of strategy and the ability of one's learning. Evaluation is the analysis of the effectiveness of performance and strategies after an academic session.[10]

MCAI Scale consisted of 52 questions or items with dichotomized response i.e.; Yes or No. Out of these 17 covered Knowledge about Cognition (4 questions for procedural knowledge, 8 questions for declarative knowledge and 5 questions for conditional knowledge), and 35 questions evaluate Regulation of Cognition (10 questions for information management strategies, 5 questions for debugging strategies, 7 questions for planning, 7 questions for comprehension monitoring and 6 questions for evaluation). Questions with "Yes" as the answer was scored '1' and "No" scored '0'.[10]

Pre-sensitization of participants was done with respect to the purpose of the study. They were instructed to tick the answer that stroke first to their mind after reading the questions so as to reduce manipulation. A total of 30 minutes was allotted to complete the questionnaire with the purpose to limit participant's bias.

First-year MBBS students who were present on the day of data collection without any known acute or chronic illness were encouraged to enrol for study purpose. Out of 150 students, 131 participated with written consent, out of which 4 entries were excluded due to incomplete information. Thus 127 entries were analyzed which consisted of 69 males and 58 females. They were further divided into 2 age groups i.e.; < 20 years and >20 years.

### Statistical analysis

Descriptive analysis like frequency, percentage, mean, standard deviation reliability assessment and inferential analysis by single sample t-test were carried out; by SPSS version 20.

## Results

127 participants were divided on the basis of age and gender. Their MCAI score was subjected to quartile analysis in order to ascertain grades for meta-cognitive function. Participant's age ranged from 18 years to 22 years with a mean age of 19.78 years where mean age for females was 19.58 yrs and males was 19.94 years. Most participants irrespective of age and gender had good and high scores across the MCAI scale and subscales. The MCAI tool recorded a good reliability score(Cronbach's α - 0.075). The detailed descriptive analysis is presented in table 1.

**Table 1:** Descriptive analysis of MCAI with respect to age and gender

| Dependant variables with grading | | Age < 20 | | | | Age >20 | | | | Total count | Total percent |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Female | | Male | | Female | | Male | | | |
| | | Count | Table N % | Count | Table N % | Count | Table N % | Count | Table N % | | |
| **Total Metacognitive Awareness Inventory Score** | Low | 6 | 4.7% | 6 | 4.7% | 4 | 3.1% | 9 | 7.1% | 25 | 19.60% |
| | Average | 10 | 7.9% | 10 | 7.9% | 6 | 4.7% | 11 | 8.7% | 37 | 29.20% |
| | Good | 9 | 7.1% | 5 | 3.9% | 11 | 8.7% | 7 | 5.5% | 32 | 25.20% |
| | High | 2 | 1.6% | 7 | 5.5% | 10 | 7.9% | 14 | 11.0% | 33 | 26.00% |
| **Knowledge about Cognition Score** | Low | 4 | 3.1% | 3 | 2.4% | 3 | 2.4% | 7 | 5.5% | 17 | 13.40% |
| | Average | 7 | 5.5% | 14 | 11.0% | 6 | 4.7% | 9 | 7.1% | 36 | 28.30% |
| | Good | 5 | 3.9% | 2 | 1.6% | 5 | 3.9% | 5 | 3.9% | 17 | 13.30% |
| | High | 11 | 8.7% | 9 | 7.1% | 17 | 13.4% | 20 | 15.7% | 57 | 44.90% |
| **Procedural Knowledge Score** | Low | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.00% |
| | Average | 1 | 0.8% | 2 | 1.6% | 2 | 1.6% | 2 | 1.6% | 7 | 5.60% |
| | Good | 1 | 0.8% | 5 | 3.9% | 2 | 1.6% | 6 | 4.7% | 14 | 11.00% |
| | High | 25 | 19.7% | 21 | 16.5% | 27 | 21.3% | 33 | 26.0% | 106 | 83.50% |
| **Declarative** | Low | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 1 | 0.8% | 1 | 0.80% |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Knowledge Score** | Average | 2 | 1.6% | 3 | 2.4% | 0 | 0.0% | 4 | 3.1% | 9 | 7.10% |
| | Good | 12 | 9.4% | 11 | 8.7% | 11 | 8.7% | 11 | 8.7% | 45 | 35.50% |
| | High | 13 | 10.2% | 14 | 11.0% | 20 | 15.7% | 25 | 19.7% | 72 | 56.60% |
| **Conditional Knowledge Score** | Low | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.00% |
| | Average | 0 | 0.0% | 0 | 0.0% | 1 | 0.8% | 1 | 0.8% | 2 | 1.60% |
| | Good | 3 | 2.4% | 3 | 2.4% | 0 | 0.0% | 2 | 1.6% | 8 | 6.40% |
| | High | 24 | 18.9% | 25 | 19.7% | 30 | 23.6% | 38 | 29.9% | 117 | 92.10% |
| **Regulation of Cognitive Score** | Low | 7 | 5.5% | 4 | 3.1% | 5 | 3.9% | 8 | 6.3% | 24 | 18.80% |
| | Average | 9 | 7.1% | 11 | 8.7% | 6 | 4.7% | 12 | 9.4% | 38 | 29.90% |
| | Good | 6 | 4.7% | 6 | 4.7% | 10 | 7.9% | 7 | 5.5% | 29 | 22.80% |
| | High | 5 | 3.9% | 7 | 5.5% | 10 | 7.9% | 14 | 11.0% | 36 | 28.30% |
| **Information Management Strategies Score** | Low | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.00% |
| | Average | 0 | 0.0% | 1 | 0.8% | 0 | 0.0% | 0 | 0.0% | 1 | 0.80% |
| | Good | 2 | 1.6% | 1 | 0.8% | 4 | 3.1% | 7 | 5.5% | 14 | 11.00% |
| | High | 25 | 19.7% | 26 | 20.5% | 27 | 21.3% | 34 | 26.8% | 112 | 88.30% |
| **Debugging Strategies Score** | Low | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.00% |
| | Average | 0 | 0.0% | 0 | 0.0% | 1 | 0.8% | 0 | 0.0% | 1 | 0.80% |
| | Good | 0 | 0.0% | 1 | 0.8% | 0 | 0.0% | 1 | 0.8% | 2 | 1.60% |
| | High | 27 | 21.3% | 27 | 21.3% | 30 | 23.6% | 40 | 31.5% | 124 | 97.70% |
| **Planning Score** | Low | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.00% |
| | Average | 1 | 0.8% | 3 | 2.4% | 0 | 0.0% | 2 | 1.6% | 6 | 4.80% |
| | Good | 10 | 7.9% | 7 | 5.5% | 8 | 6.3% | 11 | 8.7% | 36 | 28.40% |
| | High | 16 | 12.6% | 18 | 14.2% | 23 | 18.1% | 28 | 22.0% | 85 | 66.90% |
| **Comprehension Monitoring Score** | Low | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.00% |
| | Average | 2 | 1.6% | 1 | 0.8% | 1 | 0.8% | 2 | 1.6% | 6 | 4.80% |
| | Good | 7 | 5.5% | 11 | 8.7% | 4 | 3.1% | 9 | 7.1% | 31 | 24.40% |
| | High | 18 | 14.2% | 16 | 12.6% | 26 | 20.5% | 30 | 23.6% | 90 | 70.90% |
| **Evaluation Score** | Low | 0 | 0.0% | 0 | 0.0% | 1 | 0.8% | 0 | 0.0% | 1 | 0.80% |
| | Average | 4 | 3.1% | 3 | 2.4% | 2 | 1.6% | 5 | 3.9% | 14 | 11.00% |
| | Good | 5 | 3.9% | 6 | 4.7% | 5 | 3.9% | 3 | 2.4% | 19 | 14.90% |
| | High | 18 | 14.2% | 19 | 15.0% | 23 | 18.1% | 33 | 26.0% | 93 | 73.30% |

Inferential analysis by single sample't' test was used to test the study hypothesis. For this purpose, the mean scores of dependent and independent variables were calculated and computed.

Mean score of MCAI for all participants was 40.31from a maximum total score of 52. Females had an MCAI mean of 40.65 and Males 40.02. The respective mean values of subsections for Knowledge about Cognition and Regulation of Cognition was 12.91 and 27.41 from a maximum respective total value of 17 and 35. The mean scores for components of Knowledge about Cognition i.e.; Procedural Knowledge was 3.17, Declarative Knowledge was 5.71, Conditional Knowledge was 4.03, and mean scores of subsection of Regulation of Cognition i.e.; Information Management Strategies, Debugging Strategies, Planning, Comprehension Monitoring, Evaluation was 8.35, 4.39, 5.14, 5.19 and 4.33 respectively.

Unavailability of the population mean and S.D. for MCAI score led to the adoption of one sample't' test. The results thus derived demonstrated a significant association of MCAI scales and subscales in favor of younger participants and female sex. The detailed observations are presented in table 2.

**Table 2:** Result of one-sample t-test of meta-cognitive scale in relation to age and gender

| **Total Metacognitive Awareness Inventory Score:- Test value 40.31** | | | | | | |
|---|---|---|---|---|---|---|
| **Study Variables** | **t** | **df** | **Sig. (2-tailed)** | **Mean Difference** | **95% Confidence Interval of the Difference** | |
| | | | | | **Lower** | **Upper** |
| **Age** | -877.678 | 126 | .000 | -38.743 | -38.83 | -38.66 |
| **Gender** | -896.128 | 126 | .000 | -39.767 | -39.85 | -39.68 |
| **Knowledge About Cognition Score:- Test value 12.91** | | | | | | |
| **Age** | -256.964 | 126 | .000 | -11.343 | -11.43 | -11.26 |
| **Gender** | -278.679 | 126 | .000 | -12.367 | -12.45 | -12.28 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Procedural Knowledge Score:- Test value 3.17** | | | | | | |
| **Age** | -36.316 | 126 | .000 | -1.603 | -1.69 | -1.52 |
| **Gender** | -59.192 | 126 | .000 | -2.627 | -2.71 | -2.54 |
| **Declarative knowledge:- Test value 5.71** | | | | | | |
| **Age** | -93.856 | 126 | .000 | -4.143 | -4.23 | -4.06 |
| **Gender** | -116.430 | 126 | .000 | -5.167 | -5.25 | -5.08 |
| **Cognitive Knowledge Score:- Test value 4.03** | | | | | | |
| **Age** | -55.798 | 126 | .000 | -2.463 | -2.55 | -2.38 |
| **Gender** | -78.571 | 126 | .000 | -3.487 | -3.57 | -3.40 |
| **Regulation of Cognition Score: Test value 27.41** | | | | | | |
| **Age** | -585.444 | 126 | .000 | -25.843 | -25.93 | -25.76 |
| **Gender** | -605.431 | 126 | .000 | -26.867 | -26.95 | -26.78 |
| **Information Management Strategies Score: Test Value 8.35** | | | | | | |
| **Age** | -153.662 | 126 | .000 | -6.783 | -6.87 | -6.70 |
| **Gender** | -175.921 | 126 | .000 | -7.807 | -7.89 | -7.72 |
| **Debugging Strategies Score:- Test Value: 4.39** | | | | | | |
| **Age** | -63.953 | 126 | .000 | -2.823 | -2.91 | -2.74 |
| **Gender** | -86.684 | 126 | .000 | -3.847 | -3.93 | -3.76 |
| **Planning Score:- Test Value 5.14** | | | | | | |
| **Age** | -80.944 | 126 | .000 | -3.573 | -3.66 | -3.49 |
| **Gender** | -103.585 | 126 | .000 | -4.597 | -4.68 | -4.51 |
| **Comprehension Monitoring Score Test Value- 5.19** | | | | | | |
| **Age** | -82.076 | 126 | .000 | -3.623 | -3.71 | -3.54 |
| **Gender** | -104.712 | 126 | .000 | -4.647 | -4.73 | -4.56 |
| **Evaluation Score:- Test Value 4.33** | | | | | | |
| **Age** | -62.594 | 126 | .000 | -2.763 | -2.85 | -2.68 |
| **Gender** | -85.332 | 126 | .000 | -3.787 | -3.87 | -3.70 |

*The negative values are due to comparison of young vs. old and female vs. male students.

## Discussion

Various studies have been conducted to assess meta-cognitive awareness score in school children, teachers, and others but a few are done on medical graduate students. In the concluded study, meta-cognitive awareness score in the line of age and gender was assessed in first-year medical students. It was found that younger student and female have better scores in all scales and subscales of MCAI. Similar observations are reported by Pallavi P. et al. where it was found that females had better Regulation of Cognition in comparison to males which was done on 100 first-year medical students.[11] It might be due to age-related reduction in brain regions in males and pattern of brain development in which females have better interhemispheric connectivity and have bulbosity of corpus callosum which helps in cognition.[12,13] Divya Narang et al. also reported females to have higher meta-cognitive knowledge in 13-16 year age group.[14]

However, N Sawhney, S Bansal studied 100 undergraduate students from various non-professional colleges of Chandigarh and found no significant difference in meta-cognitive awareness between male and female participants.[4] Rani, and Govil,and Sarwar M. et al. also observed gender based non-difference in MCAI in their study among participants from non professional colleges.[15,16] This difference in observation could be due to higher cognitive acumen in professional graduate students.

51.2% of the total participants recorded good and high MCAI scores. Similarly, high scores for knowledge about cognition (57.3 %) and regulation of cognition (51.1%) was also documented. Scores for different subscales i.e; procedural knowledge (94.5%), declarative knowledge (92.1%), conditional knowledge (98.5%), information management strategies (99.3%), debugging strategies (99.3%), planning (95.3%), comprehension monitoring (95.3%), and evaluation (88.2%) showed impressive prevalence. Pallavi P et al. in their study found that more than 50% score of total metacognitive awareness was achieved by 87% participants and for knowledge about cognition and regulation of cognition the respective scores were 79% and 88%.[11]

## Limitation of the study

The very nature of the study design has its inherent flaw. A prospective cohort design would have been ideal in yielded valid and conclusive results.

## Strength of study

The use of universally acceptable MCAI scale with close-ended questions having high internal consistency (α - 0.90)

and intra scale -correlations (r = 0.54) provided the study it's much-needed validity.[17] Intelligent time management that restricted the participant in manipulating answer was a strategic step in reducing information bias.

## Conclusion

Estimating meta-cognition is challenging because of the complexities involved in human learning. In this study, meta-cognitive awareness inventory tool was used which was found reliable (α 0.75). Most participants did well in the assessment scale in all major sections involved in learning and female candidates and younger (<20years) students deed significantly well.

The study received ethical approval from the institutional ethical committee and there is no conflict of interest.

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## Conflict of interest

None.

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