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Metacognitive Skills and Academic Performance among Medical Students-An Analytical Cross Sectional Survey

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ABSTRACT

Objective: The study objectives were to identify the metacognitive skills in medical students and to find its association with their academic performance.

Study Design: Analytical cross-sectional study.

Place and Duration of Study: Army Medical College, Rawalpindi Pakistan, from May to Sep 2022.

Methodology: MBBS students from second, third and fourth year who had passed their last professional examination were included by convenience sampling. Sample size was calculated using WHO table and keeping 95% confidence level, d=0.05 and *p*= 0.20. Self-reported questionnaire Metacognitive Awareness Inventory was used to collect online data from 197 students. Hesitant students and incomplete questionnaires were excluded. Data analyzed through SPSS version 26. Mean and standard deviation for descriptive, independent t-test and one-way ANOVA were applied to find differences of mean among different groups ($p<0.05$ statistically significant).

Results: Among 115 males and 82 females, almost 92(46.70%) were from second year, 33(16.75%) from third year, and 72(36.54%) were from fourth year. Mean score and standard deviation of knowledge and regulation of cognition was 10±4.3 and 20.4±8.6 respectively. No significant difference of metacognition scores for two domains was found among both genders (*p* value 0.730, 0.509 respectively), four categories of percentage scores (*p*-value 0.290, 0.724respectively) and all years (*p*-value 0.077, 0.280 respectively). A significant strong positive linear correlation between knowledge and regulation was found (r= 797; $p<0.001$).

Conclusions: Metacognitive skills in medical students were moderately developed in using strategies of both knowledge and regulation of cognition. No association was found between metacognitive skills and their academic performance.

Keywords: Academic performance, Medical, Metacognition, Students (MeSH).

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INTRODUCTION

The individual's ability to assess how well they can monitor their own knowledge and use a specific strategy for problem solving is metacognition.[1] It can be simply stated that where cognition deals with an individual's ability to achieve a particular goal, meta-cognition helps individual to ensure and self-assess that learning goal has been achieved.[2] Students, especially in higher education have been shown better academic response if they are able to regulate and monitor their own learning which also help them to keep track of the loads of work with responsibility. However, use of self-regulated and metacognitive learning may differ in various contexts of specific activity or course of learning.[3] Two dimensions of metacognition that is knowledge and regulation of cognition during learning processes have been explored among students. An increase use of metacognitive strategies has been found among younger students without learning difficulties as compared to those who had learning difficulties. Nevertheless, this difference was for the use of strategy for knowledge of cognition and not for the use of strategy for regulation of cognition.[4]

An individual's knowledge about the demand of a specific learning task came under metacognitive knowledge and modifications made to plan & control learning came under metacognition regulation domain. Paucity in educational planning is highlighted as use of metacognitive strategies is found limited to the use of strategy for knowledge of cognition (declarative, procedural and conditional), and not in the use of strategy for regulation of cognition (planning, monitoring and control).[4]

The question is either metacognition is a natural trait or develop with age i.e., acquired. Some studies show that it is natural as well as acquired trait. Metacognition is an explicit behavior which cannot be measured accurately as a quantitative entity.[5]

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However, medical students can be trained to develop and increase their metacognitive abilities under guidance and repeated practice.[6,7] Mindfulness about this aspect in medical education lies in the fact that medical experts are expected to assess, monitor and improve their performance continuously.[2] A study on metacognitive development in professional educators shows that its development doesn't complete by adulthood but metacognitive skills increase with age and experience. It has been revealed that learning capabilities of students can be enhanced by giving explicit instructions about metacognition. Once these skills are learnt, students are able to utilize these strategies automatically to make adjustments if anything went wrong.[8,9]

Advanced healthcare delivery system and ongoing changes in medical knowledge needs competent future healthcare professionals who are able to manage complex situations by developing problem solving skills. The research work on identifying metacognitive skills, and need for developing these skills among medical students in our population is not that much explored. This study will encourage future researchers and medical students who are lifelong learners to become aware of metacognitive skills and will increase their motivation to cope with new interventions and emerging medical strategies. The present research was conducted to identify development of metacognition in knowledge and regulation, and its relationship with academic performance among medical students involving MBBS students from three years i.e. second, third and fourth year.

METHODOLOGY

This analytical cross sectional study was conducted in Army Medical College National University of Medical Sciences, Rawalpindi Pakistan from May to September 2022. Sample size was calculated using WHO table and keeping 95 % confidence level, d=0.05 and p= 0.20. By using convenience sampling technique data were collected through online Google documents from 245 students. After removing incomplete questionnaires or errors in response data was kept for 197 students (response rate 80%).

Inclusion Criteria: MBBS students of both genders from second, third and fourth year who had passed their last professional examination were included.

Exclusion Criteria: The students who were hesitant or did not fill the questionnaire form completely were excluded. All the participants gave informed voluntary consent before giving their responses. The ethical approval was given by the ethical committee of Army medical college, approval letter No. ERC/ID22/03.

In this research, a validated self-reported questionnaire, Metacognitive Awareness Inventory (MAI) based on 52 items was used to identify medical students' awareness about two processes or dimensions of cognition that is knowledge and regulation of cognition.[10] Assessment of "knowledge of cognition" includes declarative (5, 10, 12, 16, 17, 20, 32, 46; awareness about factors that can influence learning), procedural (3, 14, 27, 33; knowledge of strategies to use for learning) and conditional knowledge (15, 18, 26, 29, 35; choosing appropriate learning strategy. Assessment of "regulation of cognition" includes planning (4, 6, 8, 22, 23, 42, 45; goal setting before learning), monitoring (1,2,11,21,28,34,49; learning control), information management strategies (9,13,30,31,37,39,41,43,47,48; selective focusing), debugging strategies (25,40,44,51, 52; error correcting strategies), and evaluation (7,19,24, 36,38,50; assessing effectiveness of a strategy and sorting new one). For each statement there is true and false response, where true response was given score 1 and false was given 0. Total score obtained was summed up against the maximum total score of that domain to identify the mean score and standard deviation of participants.

Data was analyzed by SPSS version 26. Data normality was checked using Shapiro-Wilk test. Mean and standard deviation for descriptive and parametric tests independent-t test and one-way ANOVA were applied to find differences of metacognition among genders and percentage obtained considering p<0.05 statistically significant.

RESULTS

Among participants 115 were males and 82 were females with mean age 20.7±1.24 and the age ranging from 18 to 24 years. The participants from 2nd year were 92(46.70%), that of 3rd year were 32(16.2%) and from 4th year were 73(37%). The minimum percentage obtained by participants was 56 and maximum was 85. On the basis of percentages obtained by participants four categories were made. Almost 3(1.5%) were from 50% to 59%, 74(37.6%) from 60% to 69%, 102(51.8%) from 70% to 79%, and 18(9.1%) were from 80% to 89%.

Mean score and standard deviation of both categories of metacognition was 10±4.3 and 20.4±8.6 respectively. Total score and distribution of scores with frequencies and percentages for both domains is given in Table-I and Table-II.

Table-I: Frequencies, Mean and Standard Deviation of Different Domains of Knowledge of Cognition

Knowledge About Cognition (Total Score 17)	Mean Score & S.D (10±4.3)	
Declarative Knowledge (Total Score 8)		
Items	n/% (True responses)	Mean (S.D) of domain
I am aware of my intellectual strengths and weaknesses	132 (66.7)	4.7±2.18
I know what kind of information is most important to learn.	116 (58.6)	
I am good at organizing information.	105 (53)	
I know what the teacher expects me to learn	106 (53.5)	
I am good at remembering information.	91 (46)	
I have control over how well I learn.	112 (56.6)	
I am a good judge of how well I understand something	128 (64.6)	
I learn more when I am interested in the topic.	140 (70.7)	
Procedural Knowledge (Total Score 4)		
Items	n/% (True responses)	Mean (S.D) of domain
I try to use strategies that have worked in the past.	128 (64.6)	2.28±1.22
I have a specific purpose for each strategy I use.	99 (50)	
I am aware of what strategies I use when I study.	104 (52.5)	
I find myself using helpful learning strategies automatically	120 (60.6)	
Conditional Knowledge (Total Score 5)		
Items	n/% (True responses)	Mean (S.D) of domain
I learn best when I know something about the topic	144 (72.7)	3.03±1.5
I use different learning strategies depending on the situation	121 (61.1)	
I can motivate myself to learn when I need to.	114 (57.6)	
I use my intellectual strengths to compensate for my weaknesses.	116 (58.6)	
I know when each strategy I use will be most effective	102 (51.5)	

A Shahpiro-Wilk's test value $p>0.05$ showed that mean scores of knowledge about cognition were approximately normally distributed for four percentage categories groups with a Skewness and a Kurtosis between-1.96 and+1.96. Independent sample t-test revealed no significant difference of metacognitive scores in both genders for two domains (p-value 0.730 and 0.509 respectively), Figure-1. No significant difference of metacognition scores was found in all years for two domains on applying ANOVA-test (p-value 0.077 and 0.280 respectively). Also no significant difference of metacognition scores was found in all four categories of percentage scores. (p-value 0.290 and 0.724 respectively). A strong positive linear correlation was shown between knowledge and regulation of cognition on applying Pearson's correlation coefficient (r= .797) with a high statistical significance of $p<0.001$.

DISCUSSION

Clinical reasoning and problem solving ability is mandatory for healthcare professionals who are also life-long learners. Construction of knowledge instead of mere transfer of knowledge is possible only if students are aware of their learning which may correspondingly affect their academic performance.[10,11] In this study the development of metacognitive skills among medical students and its relation with their academic performance were measured. Evidence has shown that students can use knowledge of cognition but the regulation strategies are difficult to attain and need to be taught.[9] In this study knowledge and regulation of cognition both were moderately developed.

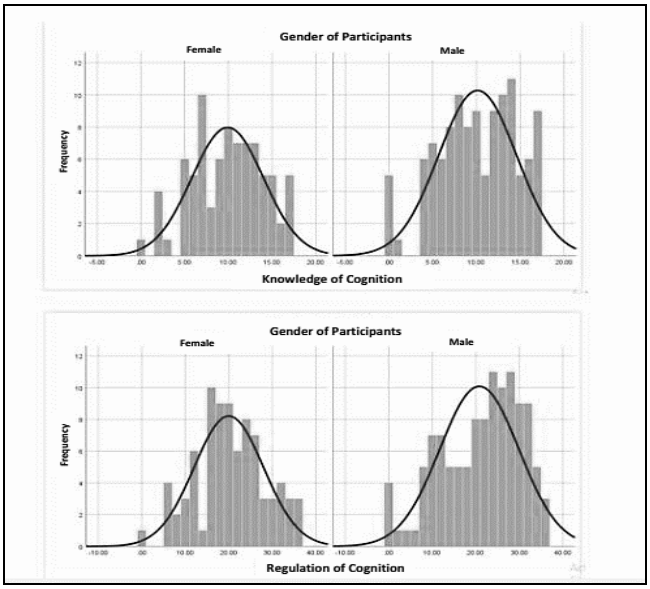

Figure-1: Difference of Mean among Males and Females in Domains of Knowledge and Regulation of Cognition

Metacognition also involves self-regulating and self-monitoring during writing process for effective writing.[8] It has been stated by different researches that those students were more organized who got more scores on metacognition and they also showed better academic performance.[12] In current research

Table-II: Frequencies, Mean and Standard Deviation of Different Domains of Regulation of Cognition

Regulation of Cognition (Total Score 35)	**Mean Score & S.D (20.4±8.6)**	
Planning (Total Score 7)		
Items	n/% (True responses)	Mean (S.D) of domain
I pace myself while learning in order to have enough time.	101(51)	3.6±2.1
I think about what I really need to learn before I begin a task	115(58.1)	
I set specific goals before I begin a task.	119(60.1)	
I ask myself questions about the material before I begin	79(40)	
I think of several ways to solve a problem and choose the best one.	101(51)	
I read instructions carefully before I begin a task.	109(55.1)	
I organize my time to best accomplish my goals.	93(47)	
Information Management Strategies (Total Score 10)		
Items	n/% (True responses)	Mean (S.D) of domain
I slow down when I encounter important information.	142 (72.1)	6.17±2.87
I consciously focus my attention on important information.	113 (57.4)	
I focus on the meaning and significance of new information.	123 (62.4)	
I create my own examples to make information more meaningful.	121 (61.4)	
I draw pictures or diagrams to help me understand while learning.	109 (55.3)	
I try to translate new information into my own words.	127 (64.5)	
I use the organizational structure of the text to help me learn.	123 (62.4)	
I ask myself if what I'm reading is related to what I already know.	115 (58.4)	
I try to break studying down into smaller steps.	125 (63.5)	
I focus on overall meaning rather than specifics.	118 (59.9)	
Comprehension Monitoring (Total Score 7)		
Items	n/% (True responses)	Mean (S.D) of domain
I ask myself periodically if I am meeting my goals.	123(62.4)	3.9±1.9
I consider several alternatives to a problem before I answer.	128(65)	
I ask myself if I have considered all options when solving a problem.	107(54.3)	
I periodically review to help me understand important relationships.	83(42.1)	
I find myself analyzing the usefulness of strategies while I study.	114(57.9)	
I find myself pausing regularly to check my comprehension.	112(56.9)	
I ask myself questions about how well I am doing while learning something new.	105(53.3)	
Debugging Strategies (Total Score 5)		
I ask others for help when I don't understand something.	120(60.9)	3.27±1.55
I change strategies when I fail to understand".	125(63.5)	
I re-evaluate my assumptions when I get confused."	129(65.5)	
I stop and go back over new information that is not clear."	129(65.5)	
I stop and reread when I get confused."	143(72.6)	
Evaluation (Total Score 6)		
I know how well I did once I finish a test.	125(63.5)	3.47±1.8
I ask myself if there was an easier way to do things after I finish a task.	120(60.9)	
I summarize what I've learned after I finish.	90(45.7)	
I ask myself how well I accomplish my goals once I'm finished.	118(59.9)	
I ask myself if I have considered all options after I solve a problem.	105(53.3)	
I ask myself if I learned as much as I could have once I finish a task.	126(64)	

participants had moderately developed skills but that was not associated with academic performance. Studies have shown that use of metacognitive strategies increases with experience.[9] On the contrary, in this study no association was found between metacognition and all three years. Instructors with better metacognitive attitude have shown positive attitude and emotions and use different strategies during teaching. Moreover, female instructors scored more in showing positive emotions and use of different strategies.[13] In this study there was no difference between metacognition and both genders as has shown by other researches.[14]

A significant correlation has been found between knowledge and regulation of cognition.[15] Evidence has been shown that this inventory can help differentiate between more and less experienced students. The adult learners differ from inexperienced students in their use of metacognitive regulatory skills.[16] It has also been revealed that improvement in metacognitive awareness and self-regulated learning skills can be achieved by using learner centered curriculum.[17]

The current study has shown a positive association between knowledge and regulation of cognition as knowledge was increased the regulation of cognition also tends to increase.

Development of metacognitive skills can result in tapping best potential of students especially healthcare professionals. Many studies have found no differences of metacognitive scores among genders, type of education or scores obtained. Still they emphasized the need of training of students in this aspect.[18,19] Likewise the participants of this study with moderately developed skills with no other differences have highlighted the need for training of the skill among them, as students having better knowledge of metacognition were able to regulate the strategies. Appropriate awareness about the metacognitive strategies and training may help learners to become more adaptive for rapidly developing system of education.[20] Medical institutions may offer this awareness in initial years for having its impact that may continue in later years.

LIMITATION OF STUDY

This was a single institutional study based on self-reported responses that may affect generalizability of results. Online collection of data may contain biased responses. For improved responses and to see the effect of awareness pre and post intervention study is recommended in future.

CONCLUSION

Metacognitive skills in medical students were moderately developed in using strategies of both knowledge and regulation of cognition. No significant difference of metacognition scores for two domains were found among both genders four categories of percentage scores and all years. The knowledge of cognition and its regulation were positively linearly associated showing that as knowledge of cognition increased the regulation of cognition also tends to increase. Suitable awareness about the metacognitive strategies plus training and instructions to use them appropriately may help lifelong learners to become more flexible for rapidly evolving education.

Conflicts of Interests: None.

Author's Contributions

Following authors have made substantial contributions to the manuscript as under:

SM: Concept, Design, Statistical analysis, Manuscript writing & Final manuscript, Proof reading & approval for the final version to be published.

FM: Final manuscript, Proof reading & approval for the final version to be published.

MU:, MP: Concept, Statistical analysis, Data collection, Manuscript writing & approval for the final version to be published.

MSA:, MHB:, FS:, MAU: Concept, Data collection, Manuscript writing & approval for the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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