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Clinical reasoning skills of medical students, Faculty of Medicine Alzaiem Alazhari University Khartoum Sudan Measured by Diagnostic Thinking Inventory (DTI)

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ABSTRACT

Clinical reasoning skills are considered as essential domain needed to be acquired to become a good physician. The Diagnostic Thinking Inventory (DTI) is a tool used for measuring critical thinking skills namely flexibility in thinking and evidence for Structure in memory. To measure the clinical reasoning skills among medical students in *Alzaiem Alazhari University*. It is cross-section study which was conducted at the Faculty of Medicine, Alzaiem Alazhari University (AAU) Khartoum, to measure clinical reasoning skills using the diagnostic thinking inventory (DTI) of 5th(92), 9th(63) semester & the newly graduate (62) a total of 181 students. The study population (74%) were under graduate (in 5th&9thSemester), while the remainder were newly graduate (26%), all were scored high levels. Tests of correlation, for the 3 subgroups, for DTI scores the flexibility of thinking & Structure of Knowledge and the standard of Bordage, Grant & Marsden in 1990 (81.6& 87.4) for the students in 5th. Semester were 0.004 & 0.000 for the 9th Semester students were, 0.001 & 0.000 while for the newly graduate students were 0.424&0.003 which were significant at $P > 0.05$ using one sample t test & Nonparametric test (Wilcoxon Signed Rank Test) was used when the data distribution was not normal. The correlation, for the 3 subgroups using one-way ANOVA was not significant (0.893& 0.680). DTI is an appropriate instrument for a comparative survey of self-assessed clinical reasoning among students at different semesters. The curriculum of AAU faculty of medicine is integrating basic and clinical sciences in solving community, family and individual health problems according to known methods of problem solving. In addition started teaching clinical reasoning skills earlier so, DTI scores were found to be high in all subgroups 5th, 9th & the newly graduate. There is Conclusive evidence that critical thinking skills and abilities can be taught, so medical curriculum should be integrated & based in problem based learning so as to graduate student with Critical thinking & good clinical reasoning skills.

Keywords: Clinical reasoning skills,, Medical students, DTI, Curriculum.

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INTRODUCTION

Clinical reasoning skills are considered as essential domain of the most important skills needed to be acquired to become a good physician. Clinical reasoning can be broadly defined as the thinking and decision making processes associated with clinical practice. It has been described as a process of hypothetic deductive reasoning, that is, a process of generating clinical hypotheses based on data collection and testing these hypotheses in order to make diagnostic and management decision ^[1]. The nature of clinical reasoning was understood so different methods were developed to assess the process E.g. the Diagnostic Thinking Inventory ^[2], the Scripts Concordance Test ^[2], and Clinical Reasoning Problems (CRP).

The Diagnostic Thinking Inventory (DTI) is a self-report inventory that is mainly based into medical diagnostic and clinical reasoning. The DTI measures two cognitive constructs that emerged from the clinical reasoning research namely flexibility in thinking and evidence for Structure in memory ^[3,4]. Flexibility in thinking refers to the use of a variety of thinking styles that can be applied during the diagnostic process while structure in memory refers to the availability of knowledge, stored in memory, during this process. Every university-level programmed of medical education must have the objective of forming good clinical reasoning skills in its students' program. The complex nature of the process of clinical reasoning, the variability of reasoning processes among different people and the potential impact on current & previous learning experiences., should be consider when we designed a curriculum & learning strategies, in addition to all that When medical school designed a curriculum, the main aimed is to graduate a doctor with clinical competency, these clinical competencies embodies three elements clinical skills, which include the technical aspects of the patient consultation (communication, history-taking, physical examination, etc.), knowledge and problem solving ability^[5].

The clinical problem is a matter of complex because there are no standardized procedures for arriving at a solution; instead, each problem is unique, and the physician can never be fully certain that the solution found is actually correct, ^[6]. When we planned strategies for teaching clinical reasoning we should apply the principles of adult learning and an environment which promotes reflection and feedback, as the same time considering the needs of the learner and the nature of the context ^[1]. Example of teaching strategy, which can be employed to promote the development of clinical reasoning skills small group learning tutorials. These can entail role playing, practice of thinking and communication skills using video or simulated clinical settings ^[7]. Teaching medical problems are complex & a lot of curriculums were modified from traditional to integrated with different modalities for teaching as well as assessments to graduate student with Critical thinking good clinical reasoning skills, that was happen in the

curriculum of AAU faculty of medicine which was modified from traditional to integrated, it is integrating basic and clinical sciences in solving community, family and individual health problems according to known methods of problem solving.

The aim of the study is to measure the clinical reasoning skills by using the diagnostic thinking inventory (DTI) by its two components thinking & structure among medical students in the Faculty of Medicine, Alzaiem Alazhari University (AAU), and Khartoum Sudan.

MATERIALS AND METHOD

Population and study procedures:

This is a cross section study conducted during the period from the February 2019 to May 2019. The study was conducted at faculty of medicine Alzaiem Alazhari University which is governmental University, its curriculum, was traditional and then modified to hybrid ,It composed of 10 semesters programmed each semester is 18 weeks with summer courses amounting to 12 weeks. Total credit hours are 180 the first year (2 semesters) is foundation ie basic sciences, from semester 3-7 are integrated & 8-10 are clinical.

Medical students volunteering to participate in this study were enrolled ,in semesters 5 at the end of preclinical year, semester9–at the end of clinical year.& the newly graduate, their total number are 202,140 & 134 respectively so their total is 476.Their Sample had been calculated using:

$$N = \frac{X}{1 + X d^2}$$

N=sample size

X=total number of study population

$d = (0.05)^2$ Degree of precision $N = 476 / (1 + 476(0.05 \times 0.05)) = 217$ students

After we calculated the number for each batch, so the sample size for the: -

Newly graduate = $134 / 476 \times 217 = 61$

Fifth academic year (semester 9) = $140 / 476 \times 217 = 64$

Third academic year (Semester 5) = $202 / 476 \times 217 = 92$

Tool of data collection: -

The data collection tool is Diagnostic Thinking Inventory (DTI), which was modified by Bordage, Grant & Marsden in 1990, its reliability was tested using alpha coefficient which was found to be 0.83 which was acceptable the inventory includes Demographic profile which include, sex, age, region, semester & type of curriculum, in addition to 41 items concerning diagnostic in terms of question. Each item contains a stem, two accompanying statements and a rating scale. The scale refers to a continuum between the two statements. It takes about 15 to 20 minutes to complete the inventory. These questions 2,3,4,5 ,6,11 15,16,23,24,26,27,28,30,32,34,35,36,38,40,41 concern with Flexibility of thinking, which

related to the capacity of the responders retain a flexible approach to diagnose a problem, their maximum score is 126, example: -

2. In considering each diagnosis,

I try to evaluate their relative importance

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I try to give them equal importance or weighting

Concerning the structure of memory is related to the ease with which the responder can access information stored in his memory its questions are 1,7,8,9,10,12,13,14,17,18,19,20,21,22,25,29,31,33,37,39 their maximum score is 120, example: -

1. When the patient presents symptoms,

I think of the symptoms in the precise words used by the p

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I think of the symptoms in more abstract terms than the expressions actually used (e.g. '4-day duration' becomes 'acute'; 'two-hands' becomes bilateral)

Data management & methods of analysis: -

Data analysis was performed using SPSS (Statistical Package for Social Sciences). Data was expressed in form of statements, tables and figures. The mean \pm standard deviation & tests of normality was calculated for the DTI scores which are flexibility of thinking, Structure of Knowledge in memory & the total score. Then DTI scores of third & fifth academic year as well as the newly graduate were compared with the standard of Bordage, Grant & Marsden in 1990 using one sample t test. Correlation between the DTI scores of the three groups were compared using one-way ANOVA Nonparametric tests were used when the data distribution was not normal. A significance level of 5% was chosen. The study was approved from Khartoum University research ethical committee, the participants were consented verbally.

RESULTS AND DISCUSSION

General Characteristic of the study population:

The study population were, medical students (AAU), their total number was 181, their age group was ranged between 20-25 years, 97(54 %) were male & 84(46 %) were female as shown in Figure (1). 133 (74%) were under graduate (in 5th&9th.Semester), while the remainder were newly graduate 48(26%).

The response rate for all subject groups is presented in table 1. The overall response rate was 83.4%. The response rate for final students (9th semester) was the highest (89%), while for newly graduates (78.7%) was relatively low.

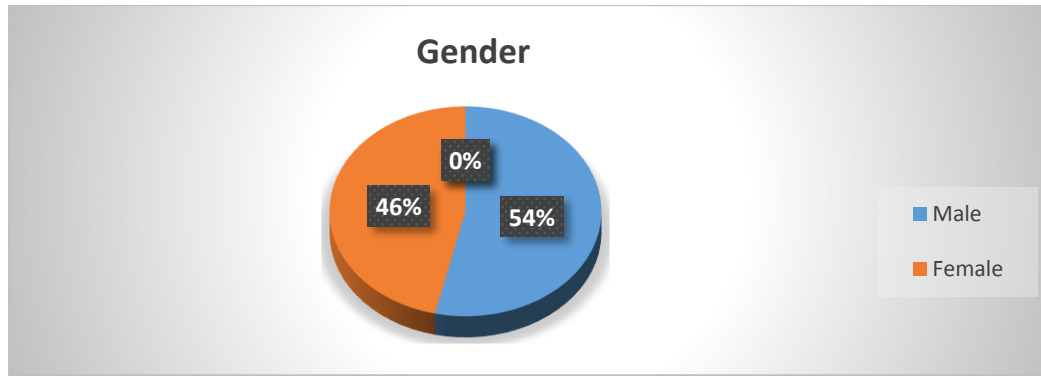


Figure 1: Gender distribution of study population

Table 1: The response rate from each subject group:-

Name of the Responder	Calculated Sample size	Responders No.	%
5 th .Semester	92	76	82.6
9 th .Semester	64	57	89
Newly graduate	61	48	78.7
Total	217	181	83.4%

Descriptive analysis of DTI:-

The data collection tool is Diagnostic Thinking Inventory (DTI), which was modified by Bordage, Grant & Marsden in 1990, its reliability was accepted & its alpha coefficient was 0.83.

The means & standard Deviation of flexibility of thinking & Structure of Knowledge in memory for all the study population (181 students) were calculated and was found to be normally distributed.

The means, standard Deviation & the range of DTI scores (flexibility of thinking, Structure of Knowledge in memory & the total score) for the three subgroups in 5th&9th.Semester & the newly graduate were also calculated, The DTI results demonstrate that students in 5th semester scored high mark in Flexibility in thinking & Structure of Knowledge in memory their means were (85.6 ±11.89),& (87.8± 13.15) while that of 9th semester were (86.6 ±10.71) (86.8 ±11.23)& for newly graduates were **(86.0 ± 12.04)&(88.9 ±11.56) respectively**. The mean total score of students in 5th &9th semester (undergraduate) were almost the same 173.4 ±23,173.4±18 while that for the newly graduate was 174.9±23 Table 2.

Table 2: DTI Results

Student level	Student No.	DTI scores	Mean \pm SD	Range
5 th .Semester	76	-Flexibility in thinking (maximum=120)	85.632 \pm 11.89	56--111
		Structure of Knowledge in memory (maximum=126)	87.803 \pm 13.15	55--113
		Total score (maximum=246)	173.4342 \pm 22.94	116--210
9 th .Semester	57	Flexibility in thinking (maximum=120)	86.596 \pm 10.71	59--108
		Structure of Knowledge in memory (maximum=126)	86.842 \pm 11.23	62--115
		Total score(maximum=246)	173.4386 \pm 17.59	133--216
Newly graduate	48	-Flexibility in thinking (maximum=120)	86.000 \pm 12.04	46--108
		-Structure of Knowledge in memory (maximum=126)	88.938 \pm 11.56	69--113
		-Total score (maximum=246)	174.9375 \pm 21.72	116--214
Total	181	-Flexibility in thinking (maximum=120)	86.03 \pm 11.51	46-111
		-Structure of Knowledge in memory (maximum=126)	87.8 \pm 12.12	55-115
		-Total score (maximum=246)		

Tests of Normality

Kolmogorov-Smirnov was calculated as a test of normality for DTI scores table 3.

Table 3 Tests of Normality: -

	<i>Kolmogorov-Smirnov^a</i>		
	<i>Statistic</i>	<i>df</i>	<i>Sig.</i>
-Flexibility in thinking			
5th.Semester	.072	76	.200*
9th.Semester	.096	57	.200*
Newly graduate	.091	48	.200*
-Structure of Knowledge in memory			
5th.Semester	.111	76	.021
9th.Semester	.077	57	.200*
Newly graduate	.133	48	.032

Total score			
5th.Semester	.091	76	.188
9th.Semester	.085	57	.200*
Newly graduate	.095	48	.200*

Tests of Significance:

Tests of correlation, for the 3 subgroups, for DTI scores the flexibility of thinking & Structure of Knowledge and the standard of Bordage, Grant & Marsden in 1990 (81.6& 87.4) for the students in 5th. Semester were 0.004 &0.000 for the 9th Semester students were, 0.001 & 0.000while for the newly graduate students were 0.424&0.003 which were significant at $P>0.05$ using one sample t test &Nonparametric test (Wilcoxon Signed Rank Test) was used when the data distribution was not normal. The correlation, for the 3 subgroups using one-way ANOVA was not significant (0.893& 0.680).

DISCUSSION:

The main aim of medical school is to graduate clinical competent doctor who master clinical skills, concerning history taking, examination & the end his ability to solve patient problem, In term of clinical reasoning skills the theory indicates that the more experienced the subjects, the better their clinical reasoning skills.

The responder rate of the students was high in spite of the fact that we had problems in Sudan concerning internet access and electricity. The students of semester 9 scored the high rate because they available in the faculty and easy understood the tool while that of newly graduate was low which was explained by the fact they were graduated and we caught them when they came for their certificates.

The DTI means score of the three subgroups students in 5th semester(third year) 9th semester(final year) & newly graduates scored high mark in Flexibility in thinking & Structure of Knowledge in memory, these results were explained by the fact that the AAU curriculum is integrated, basic sciences with clinical practice in addition to that problem - oriented learning as well as Community - based educational ,these results goes with Stieger & his collogues whom were studied the diagnostic grand rounds a new teaching concept to train diagnostic reasoning they concluded that the students' DTI results improved significantly when the student involved in clinical problem solving,&, in addition to handling patient cases, through participation in diagnostic case discussions^[8].

The mean total score of students in 5th &9th semester (undergraduate) were almost the same& were higher than those reported by Bordage (158.3) ^[3] ,these finding of 3rd year (5th semester),might be explained by the fact that these students were not encountered many patient problems & find difficulties indicating how they actually diagnose. Consequently they probably thought what they should do & try to find the right answer, not what they may actually do in practice ^[9].

The mean total score of newly graduate was higher than that of undergraduate (5th & 9th semester) which means the clinical reasoning is improved with increasing semesters of study [37].

The mean total score of the newly graduate (174.9) was higher than similar cohorts from previous studies like Sobral, whom were studied the diagnostic ability of medical students by (DTI) among clinical clerkship students, mean total score of their students was (168.59) their results revealed that higher scores of the DTI measures were associated with students' high self-confidence, high motivation to learn, in addition to higher scores for structure in memory were obtained with an integrated teaching background and problem-based learning^[10].

DTI scores by its two components the Flexibility in thinking & Structure of Knowledge in memory, among the 2 subgroups, medical students of semester 5th, 9th & the Structure of Knowledge in memory among the newly graduate were correlated with standard of Bordage^[3] & were found to be significant, these might be explained by the fact that, when AAU faculty of medicine modified and designed the curriculum & planned teaching, they applying small groups learning activities like tutorials, & bed site teaching so as to promote the development of clinical reasoning skills among the students earlier, these facts were stated by Higgs J1990 who was conducted his research *Fostering the acquisition of clinical reasoning skills* he concluded that by applying small groups learning can entail role playing, practice of thinking and communication skills and so promoting & mastering clinical reasoning skills^[7].

Teaching medical problems are complex & a lot of curriculums were modified from traditional to integrated with different modalities for teaching as well as assessments to graduate student with Critical thinking good clinical reasoning skills, this actually what was happen in AAU its curriculum, was traditional for 5 years then modified to hybrid 1998, the faculty planned strategies for teaching clinical reasoning by apply the principles of adult learning and an environment which promotes reflection and feedback, as the same time considering the needs of the learner and the nature of the context^[1]. The faculty adopts seminars and small group discussions, field practice in rural and primary health care, practical sessions laboratory, clinical & limit the Lectures to less than 1/3rd of the curriculum timetable, from now and then the faculty update the curriculum by internal and international figures to assess its content & it is suitable to our context. it is important to deliver the knowledge in the classroom properly with skill learner to enrich classroom learning experiences, in addition to the clinical role models are particularly important since exploration of the greater experience-based and knowledge of clinicians enables students to develop a rich range perspectives and alternatives which they may adopt or use as comparisons for their own developing ideas^[11]. In addition to the class room, clinical setting plays an important part in developing the student's knowledge base.

The inventory measures the self-assessment of the participants on the type and structure of their clinical reasoning, but it does not measure their actual diagnostic ability [12]. The mean score of Flexibility in thinking among newly graduate which is almost equal to undergraduate & its test was not significance the three study group studied the same curriculum, this might be explained by the comment of Findyartini & his colleges when they studied how clinical reasoning is taught and learned is that the higher DTI scores only reflect a greater familiarity with the thinking process in diagnostic reasoning and do not necessarily represent better diagnostic performance [13]. In addition to The DTI, moreover, required the respondents to answer each item based on what they would do, not what they should do, in patient encounters [9].

DTI scores by its two components the Flexibility in thinking & Structure of Knowledge in memory & its total scores, among the 3 subgroups, medical students of semester 5th, 9th & the newly graduate, were correlated using one-way ANOVA & the P values were not significant. This results might be explained by the fact that, the AAU faculty of medicine One of the faculty objective is Integration of basic, and clinical sciences in solving community, family and individual health problems according to known methods of problem solving. In addition to in the system phase which started from semester three teaches the student in the skill lab and then shift to real patients in the hospitals after their agreement and we considered the patients privacy, so the student start to learned the critical thinking & reasoning skills earlier so their DTI scores were high in the three studied groups and when correlated were no significant. In Clark phase from semester 7- 10 the clinical settings are general hospital as well as specialized ones, health centers, & rural residences in different states of Sudan to enable the students to be familiar & act independently & can react with the community under supervision. Concerning the clinical examination were in form of objective structure clinical examination (OSCE), simulated & real patients are there

However, the first

Limitations

This was cross sectional study encircling a small part of students of faculty of medicine AAU Data collection tool (DTI) was one of difficulties faced by the researcher in the stage of the data collection ,how to login and to answer the questions in addition to internet connection & some problems encounter the website and its settings sometimes ,this may be the cause of ,our responder rate ,instead of 100% was 83.4,in addition to the time limitation, this may be has affected some of the results.

CONCLUSION:

In summary, the present cross section study indicates that the DTI is an appropriate instrument

for a comparative survey of self-assessed clinical reasoning among students at different semesters. AAU faculty of medicine its curriculum is integrated one of main objective is Integration of basic and clinical sciences in solving community, family and individual health problems according to known methods of problem solving. In addition to started to teach clinical reasoning skills earlier so, DTI scores were found to be high & its correlation tests were significant in all subgroups 5th, 9th & the newly graduate, while the correlation between the subgroups was not significant.

Recommendation

There is Conclusive evidence that critical thinking skills and abilities can be taught, so medical curriculum should be integrated & based in problem based learning so as to graduate student with Critical thinking & good clinical reasoning skills. Clinical competency of medical student should be measured and assess before graduation. The DTI itself used in cohort study in the AAU faculty of Medicine for example started with first year, and then repeated yearly in the same batch until they graduate so as to assess the improvement of their critical thinking ability. The DTI itself should be further validated with other specialized, objective tests for clinical reasoning and conduct for example key feature, script concordance or situational judgment tests & clinical Reasoning Problem.

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