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Assessment the Performance of Biomedical Sciences and Medical Students in Diagnosing and Reporting of Histological/Histopathological Sections

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Abstract

Background: *This study assessed the performance of Biomedical Sciences students in diagnosing and reporting histological/histopathological sections and compared their performance with the Medical students.*

Methods*: A prospective multi-center cross sectional study was done among Medical and Biomedical Sciences students in their final year. A stratified sampling technique was used to select a sample of 122 students out of total of 412. A self-administrated questionnaire designed through Epi-info 7 was used to collect the data. Information collected include characteristics of the participants, reading, diagnosing and reporting of histological/histopathological sections under virtual microscope from Indiana University School of Medicine online website. The statistical package for social sciences (SPSS version 23) was used to perform descriptive statistics and statistical analysis. Chi-square tests were conducted to determine association/ difference between variables which were primarily validated through*

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Cronbach's alpha test. A binary logistic regression predicted the factors associated to the diagnosing and reporting. All statistical tests were considered as statistically significant when p <0.05.

***Results**: There was no statistical significant differences between faculties (p =0.487), gender, age, extra courses taken and microscopical identification with p value of, 0.693, 0.119 and 0.749 respectively.*

***Conclusions**: Our findings revealed that students of biomedical sciences were capable to implement histopathological diagnosis; which indicated that a training in histopathological reporting will enhance their capacities to both diagnosing and reporting histopathological findings.*

Keywords: Biomedical sciences, Biomedical scientist, Diagnosing, Histology, Histopathology, Laboratory technologist, Medical doctors, Medical Technologist, Reporting.

INTRODUCTION

Biomedical scientists are responsible for investigating and diagnosing patient illnesses [1]. Their work is primarily lab-based, using advanced medical equipment and automated systems to grow, test and analyze cultures from infected samples [1]. The three specialties (major) in Biomedical field are namely infection sciences (clinical microbiology, virology, and immunology); blood sciences (clinical chemistry, transfusion science, and hematology); Cellular sciences (histopathology, cytology, and reproductive sciences) [1].

In Sudan, Biomedical Sciences is a four-year program within faculties concerned in universities. Three years of general courses focused on medical laboratory technology and basic medical sciences; the last year for specialization in one of the three major of biomedical sciences. At graduation from a faculty of biomedical sciences according to the Sudan Health Profession Council register the recipients are delivered a certificate of medical technologist [2].

While laboratory technologists specialized in infection sciences or in blood sciences are authorized to diagnose and report laboratory findings then convey their results to physicians and medical

specialists responsible for final decision and treatment; those specialized in cellular sciences are denied diagnosing and reporting their histopathology findings. Their contribution is restricted to preparation of histopathological slices and handling them to the pathologist for diagnosing and reporting. This contradiction regarding the three majors of biomedical sciences is explained by Sudanese Ministry of Higher Education and Scientific Research Statistics has a consequences of the absence of clear and defined career profile for biomedical scientists specialized in cellular sciences in the field of pathology in Sudan. Those specialized in cellular sciences are authorized to diagnose and report under the conditions they obtained a medical degree, fulfilled the four years of specialized training in the four branches of pathology [2,3]. This was an issue for histopathology and cytology department in UK for the last 15 years until the Royal Collage of Pathologist (RCPath) and Institute of Biomedical Science (IBMS) accepted the reporting of abnormal cervical smear by Biomedical Scientists [4]. They also have accepted the reporting of selected ophthalmic pathology specimens by Biomedical Scientists [4]. This move was consolidated and validated by Meeney A et al. who compared the reporting of corneal pathology between Biomedical Scientists and Consultant Ophthalmic Pathologists. The findings revealed that Biomedical scientist diagnoses matched the Consultant diagnoses in 88% (44/50) cases after 6 months training in advanced diploma in ophthalmic pathology, and 96% (48/50) cases after 24 months. [5]

Hence, our study compared the performance of Biomedical Sciences and Medical students in diagnosing and reporting histological/histopathological sections.

METHOD

A prospective multi-center cross-sectional study was conducted among Medical and Biomedical Sciences students in the final year (5th year of medicine and 4th year of biomedical sciences) of each of the two faculties of three universities, which were namely University of Medical Sciences and Technology (UMST), University of Khartoum (U of K) and Elrazi University. A stratified random sampling technique was used to select 112 students out of a total of 412 enrolled in the

three universities during the academic year 2017-2018. The data were collected through a standardized self-administrated questionnaire adapted from Indiana University School of Medicine online website slide1 [6], slide2 [7], slide3 [8], slide4 [9], slide5 [10] and complemented by the researcher to enable to collect appropriate data related to histology and histopathology slides identification for diagnosis and reporting. Students from each of the two faculties were provided with five different histological \histopathological sections under virtual microscope. The data collected included also the characteristics of the participants (age, gender, faculty, specialization and extra courses taken). The collected data were computerized through a template designed through Epi-info 7. Then uploaded in the statistical package for social sciences (SPSS version 23). The data were firstly summarized numerically and graphically. Cronbach's alpha test [11] was used to measure the reliability of the answers of students. Association between variables were determined through chi-square tests. A Binary regression analysis was preformed to predict the factor associated to the diagnosing and reporting of histology and histopathological sections. All statistical tests were considered as statistically significant when $p < 0.05$.

RESULTS

Characteristics of study participants

Of the 112 students, informed consent was obtained from 81% (91/112) of the students (Medicine n=48, Biomedical sciences n=43). The majority were females (61.5%, 56/91) and the remaining 38.5% (35/91) were males. Their age ranged between 19 and 30 years with a median of 22 years. They were distributed in three universities, which were namely Elrazi (54.9%, n=50), UMST (31.9%, n= 29), U of K (13.2%, n=12). 52.7% (48/91) were from faculty of Medicine and 47.3% (43/91) from faculty of Biomedical sciences.

Evaluation of slide one

A Cronbach Alpha test was performed on three items related to the type of tissue, histopathological type and final report. A Cronbach Alpha value of 0.209 was obtained, this indicated controversial answers provided by the participants on each of the three items.

The majority (73.6%, 67/91) of the participants correctly answered the type of tissue section as Thyroid gland; 76.6% (70/91) identified the histopathological type as benign, and 98.9%, (90/91) drafted an incorrect histopathological report. (Table 1)

Table 1: Responses of participants in reading the histological/histopathological slides (1-5)

Variable	Number	%	Variable	Number	%
Responses of participants in reading slide 1			**Responses of participants in reading slide 3**		
Type of tissue section (n=91)			**Type of tissue section (n=91)**		
Thyroid gland	67	73.6	Liver	80	87.9
Ovary	7	7.7	Pancreas	8	8.8
Lung	11	12.1	Lung	3	3.3
Spleen	6	6.6	**Normal or abnormal (n=91)**		
Histopathological type (n=91)			Normal	77	84.6
Benign	70	76.9	Abnormal	14	15.4
Malignant	21	23.1	**Final report section (n=91)**		
Final report (n=91)			Correct	29	31.9
Correct	1	1.1	Incorrect	62	68.1
Incorrect	90	98.9			
			Responses of participants in reading slide 4		
Responses of participants in reading slide 2			**Structure in the tissue (n=91)**		
Type of tissue section (n=91)			Bronchi	5	5.5
Skin	62	68.1	Bronchioles	9	9.9
Urinary Bladder	21	23.1	Alveoli (air sacs)	77	84.6
Gall Bladder	3	3.3			
Rectum	5	5.5	**Responses of participants in reading slide 5**		
Structure in the tissue (n=90)			**Normal or abnormal (n=91)**		
Melanin	60	65.9	Abnormal	85	93.4
Schistosoma's egg	22	24.2	Normal	6	6.6
Glycogen	4	4.4			
Lactobacilli bacteria	4	4.4	**Final report section (n=91)**		
Normal or abnormal (n=90)			Correct	19	20.9
Abnormal	59	64.8	Incorrect	72	79.1
Normal	31	34.1			
Histopathological type (n=61)					
Malignant	27	29.7			
Benign	34	37.4			
Final report section (n=91)					
Correct	13	14.3			
Incorrect	78	85.7			

Microscopical Identification (Diagnosing) and reporting

Regarding microscopical identification, 61.5% (56/91) of the participants provided a correct answer. The correct answer was higher in Biomedical sciences (65.1%, 28/43) than in Medicine 58.3% (28/48), but there was no statistical significant difference between microscopical identification and faculty (chi-square =0.441, p=0.507). Concerning final reporting, only a student (1/48) from the Faculty of Medicine provided a correct report. (Table 2)

Table 2: Diagnosing and reporting of slide 1 by Medical and Biomedical Sciences students (n=91)

	Microscopical Identification 1				
Faculty	**Wrong**	**Right**	**Total**	**% Right**	***p-value***
Medicine	20	28	48	58.3	
Biomedical Sciences	15	28	43	65.1	0.507*
Total	**35**	**56**	**91**	**61.5**	
	Final report section 1				
Faculty	**Correct**	**Incorrect**	**Total**	**% Correct**	
Medicine	1	47	48	2.1	
Biomedical Sciences	0	43	43	0	
Total	**1**	**90**	**91**	**1.1**	

Evaluation of slide number two

The consistency of the answers of participants for reliability was tested through Cronbach's Alpha for five items (type of tissue, structure in the tissue, normality, histopathological type and final report). The value of Cronbach's Alpha obtained was 0.652 which indicated that the participant answers were consistent and not controversial.

Of the 91 participants, the majority (68.1% n= 62) addressed the type of tissue section as skin, and 85.7% (n=78) gave an incorrect final report. Regarding the structure in the tissue and the normality of the section, 90 students answered the related two questions, it was melanin for 65.9% (60/90) of students and 64.8% (59/90) answered it was abnormal. Of the 61 students who answered the histopathological type, the majority (37.4%, 34/61) answered it was benign (Table 1).

Microscopical Identification and reporting

Regarding microscopical identification, 24.2%, (22/91) of the participants provided the correct answer. The correct answer was higher in Biomedical sciences 27.9% (12/43) than in Medicine 20.8%

(10/48), but there was no statistical significant difference between microscopical identification and Faculty (chi-square =0.619, p=0.431). Concerning final reporting, 20.8% (10/48) students from the Faculty of Medicine provided a correct report but there was no statistical significant difference between final report and faculty (chi-square =3.557, p=0.059). (Table 3)

Table 3: Diagnosing and reporting of slide 2 by Medical and Biomedical Sciences student (n=91)

	Microscopical Identification 2				
Faculty	**Wrong**	**Right**	**Total**	**% Right**	***p-value***
Medicine	38	10	48	20.8	
Biomedical Sciences	31	12	43	27.9	0.431*
Total	**69**	22	**91**	**24.2**	
	Final report section 2				
Faculty	**Correct**	**Incorrect**	**Total**	**% Correct**	
Medicine	10	38	48	20.8	0.059*
Biomedical Sciences	3	40	43	7.0	
Total	**13**	**78**	**91**	**14.3**	

Evaluation of slide number three

A Cronbach Alpha test was performed on three items related to the type of tissue, normality and final report. A Cronbach Alpha value of 0.325 was obtained. This indicated divergent answers provided to each of the three items.

Of the 91 participant the majority 87.9% (80/91) correctly answered the type of tissue section as liver; 84.6% (77/91) identified the normality of tissue as normal, and 68.1%(62/91) drafted an incorrect histopathological report (Table 1).

Microscopical Identification and reporting

Regarding microscopical identification, 74.7% (68/91) of the participants provided correct answer. The correct answer was higher in Biomedical sciences 76.7% (33/43) than in Medicine 72.9% (35/48), but there was no statistical significant difference between microscopical identification and faculty (chi-square =0.176, p=0.675). Concerning final reporting, correct answers were higher in the faculty of Biomedical Sciences 32.6% (14/43) than in Medicine 31.3% (15/48). Though no statistical significant difference was found between final reporting and faculty (chi-square =0.18, p=0.894). (Table 4)

Table 4: Diagnosing and reporting of slide 3 by Medical and biomedical sciences student (n=91)

	Microscopical Identification 3				
Faculty	**Wrong**	**Right**	**Total**	**% Right**	***p-value***
Medicine	13	35	48	72.9	
Biomedical Sciences	10	33	43	76.7	0.675*
Total	**23**	68	**91**	**74.7**	
	Final report section 3				
Faculty	**Correct**	**Incorrect**	**Total**	**% Correct**	
Medicine	15	33	48	31.3	
Biomedical Sciences	14	29	43	32.6	0.894*
Total	**29**	**62**	**91**	**31.9**	

Evaluation of slide number four

The majority 84.6% (77/91) correctly read slide four and recognized the structure in the tissue section as alveoli (air sac); alveoli was the only correct answer out of a set of four possible answers (Table 1). The same proportion (84.6%, 77/91) provided correct microscopical identification. Despite the correct answer was higher in the faculty of Medicine (87.5%, 42/48) than in the faculty of Biomedical sciences (81.4%, 35/44), there was no statistical significant difference between microscopical identification and faculty (chi-square =0.649, p=0.420). (Table 5)

Table 5: Diagnosing and reporting of slide 4 by Medical and biomedical sciences student (n=91)

	Microscopical Identification 4				
Faculty	**Wrong**	**Right**	**Total**	**% Right**	***p-value***
Medicine	6	42	48	87.5	
Biomedical Sciences	8	35	43	81.4	0.42
Total	**14**	77	**91**	**84.6**	

Evaluation of slide number five

The consistency of the answers of participants was tested through Cronbach's Alpha for two items which were namely normality and final report. The value of Cronbach's Alpha obtained was 0.217; this value, out of the range of reliability (0.70-0.95) indicated that the participant answers were controversial. Of the 91 participants, the majority (93.4%, 85/91) answered the normality of the tissue section as “abnormal” (Table 1); the correct answer was higher in Biomedical sciences 95.3% (41/43) than in Medicine 91.7% (44/48). 79.1% (72/91) drafted an incorrect histopathological report (Table 1). The correct answer was higher in faculty of Medicine 25.0% (12/48) than in

Biomedical Sciences 16.3% (7/43), this difference was not statistically significant between final reporting and faculty (chi-square =1.044, p=0.307). (Table 6)

Table 6: Diagnosing and reporting of slide 5 by Medical and biomedical sciences student (n=91)

	Microscopical Identification 5				
Faculty	**Wrong**	**Right**	**Total**	**% Right**	***p-value***
Medicine	4	44	48	91.7	
Biomedical Sciences	2	41	43	95.3	
Total	**6**	85	**91**	**93.4**	
	Final report section 5				
Faculty	**Correct**	**Incorrect**	**Total**	**% Correct**	
Medicine	12	36	48	25	
Biomedical Sciences	7	36	43	16.3	0.307*
Total	**19**	**72**	**91**	**20.9**	

Final diagnosing and reporting the five slides

In the overall, the participants were evaluated based on a score of the reading all the five slides which was labeled as wrong or right. Regarding the final microscopical identification, the response of the majority (91.2%, 83/91) were wrong; fewer (8.8%, 8/91) had right answer. The correct answer was higher in Biomedical sciences 9.3 (4/43) than in Medicine 8.3% (44/48). However, regarding the final reporting all (91/91) the participants failed to report correctly. (Table 7)

Table 7: Final results of diagnosing of the five slides by Medical and Biomedical students (n=91)

	Microscopical Identification final			
Faculty	**Wrong**	**Right**	**Total**	**% Right**
Medicine	44	4	48	8.3
Biomedical Sciences	39	4	43	9.3
Total	**83**	8	**91**	**8.8**

Factors affecting the diagnosing and reporting of Biomedical sciences and Medical students

A binary logistic regression model was used to predict the factors affecting Biomedical sciences and Medical students diagnosing and reporting. A set of four predictive variables were used; there were namely age, gender, extra courses taken, microscopical identification. The Goodness of the fit of the model revealed a reliability of the data of 58.2%.

The model revealed that there was no statistical significant difference between the two faculties and gender (p =of 0.487), age (p =, 0.693), extra courses taken (p= 0.119) and microscopical identification (p= 0.749) (Table 8).

Table 8: Regression model predicting diagnosis and reporting histological/ histopathological sections by medical and biomedical students based on age, gender, extra courses taken, microscopical identification.

Variables	B[1]	S.E.	Wald[2]	df	*P*	OR[3]	95% C.I.for OR	
							Lower	Upper
Gender	.313	.450	.484	1	.487	1.367	.566	3.301
Age	-.046	.117	.156	1	.693	.955	.759	1.201
Extra courses	-1.328	.851	2.432	1	.119	.265	.050	1.406
Microscopical identification	-.242	.756	.102	1	.749	.785	.178	3.458
Constant	1.154	2.608	.196	1	.658	3.172		

1.Coeffectient of contribution to the model. 2. Chi-square in logistic regression. 3. Odds ratio estimating the times of contribution

DISCUSSION

Of the 91 students who participated in the study only 8.8% (8/91) from faculties of Medicine and Biomedical Sciences gave a correct diagnosis of the five sections provided to them. They were 9.3% (4/43) from the faculty of Biomedical Sciences and 8.3% (4/48) were from the faculty of Medicine leading to a difference of 1% between the two faculties. This may confirm that Biomedical Sciences students have the knowledge and ability to make diagnosis as their counterpart Medical students. This finding were consistent with study conducted in London in 2013 [5].

None of the 91 study participant gave a correct final report of all the five sections provided to them. Although there was some variation in the report for each slide, Medical students answered correctly slides 1,2,5 with a correct reporting of respectively 1.1% (1/48), 20.8% (10/48), 25.0% (12/48). Biomedical Sciences students correctly answered slide 3 with a correct report of 32.5% (12/43). This finding indicated that the deficiency in making the final report of students of the faculty of Biomedical Sciences was due to insufficient knowledge in pathology, as well as a lack of training in scientific pathological reporting rather than an inability of reporting. Moreover, it could be related to the absence of standardized and harmonized

curriculum and credit hours in pathology and histopathology across the universities, as already reported by a study conducted 2013[5]. A proper training based on a well-designed curriculum and well define will capacitated biomedical scientists in making final diagnosis. The training of biomedical scientist in making final diagnosis was emphasized by the joint statement of the Royal College of Pathologists and the Institute of Biomedical Science [4] and confirmed by varies consultants, pathologists and doctors who agreed that the biomedical scientists were capable to diagnose and report histological/ and histopathological sections [12].

None of the four predictors (gender, age, extra courses taken and Microscopical identification) were statistically ($p > 0.05$) associated to diagnosing and reporting histological/ histopathological sections among faculties. Our findings disclaimed the opinion of consultants and doctors who assumed that the diagnosis should be performed biomedical scientist only under the condition that they acquired a medical degree [12].

A limitation of our research was it targeted population which were final year Medical and Biomedical Sciences students. However, this option was acceptable as the orientation to become histopathologist starts after final year. Medical student after obtaining Medical Degree (MD) go through two years to fulfill one of the four branches of pathology and two additional years in histopathology. In the other hand, Biomedical Sciences students after graduation need to go through medical schools and complete four additional years in histopathological training. This limitation is one of the weakness of the universities that our study wanted to point. Another limitation was the implementation of our research at the end of the academic year period in which students were struggling between taking final exams, assuming hospitals rounds and shifts and had to devote time to our research instrument.

Our research was not arguing on the term of reference of Medical doctors specialized in histopathology, but it was an appeal for a team work to enable Biomedical Scientists in histopathological department to diagnose and report histopathological sections as their counterpart medical doctors specialized in histopathology for the sake of patients.

This study concluded that biomedical sciences students are able to make histopathological diagnosis, and with a proper training they will be able to report a correct histopathological report. Hence it suggests that since there are no differences in the diagnosis of histopathological sections between faculties of Medicine and Biomedical Sciences, both should continue to practice four years of pathology directly without the need of biomedical scientist to go through medical degree. Moreover, to improve the reporting ability of the biomedical scientist the curriculum of histopathology should include a section on capacitating / strengthening the knowledge of students in reporting. Also it would be advisable to standardize the credit hours and curriculum of histopathology among universities. A country-wide comparative multi-center research between faculties of Medicine and Biomedical Sciences is urgently recommended to validate our findings and increase the accuracy and precision. In order to generalize the results, it is important to carry out a comparative research among graduated biomedical scientists and trained biomedical scientists in histopathology diagnosing and reporting, and compared the results of both groups with the ones of consultants.

Ethical consideration

Permission was obtained from the dean of each faculty of the three universities covered by the study. A verbal and a written consent were taken from each student participating in the study. All the information and data were kept confidential by attributing a unique identification code to each participant.

Author Contributions

N.M.A.B designed and implemented the research, the data analysis and drafting the manuscript

Roles: Conceptualization, Project Administration, Data Curation, Formal An,alysis, Methodology Funding Acquisition, Investigation, Validation, Visualization, Resources, Writing – Original Draft Preparation, Review & Editing.

B.A.E.A implemented the research and the data analysis

Roles: Project Administration, Data Curation, Formal Analysis, Investigation, Review & Editing.

M.N supervised the research and proof read the manuscript

Roles: Project Administration, Formal Analysis, Methodology, Supervision, Writing – Review & Editing.

Competing interests
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