Brief Communication

Resident physician's knowledge and attitudes toward biostatistics and research methods concepts

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ABSTRACT

Objectives: To assess the knowledge and attitudes of resident physicians toward biostatistics and research methodology concepts.

Methods: We conducted a cross-sectional study between November 2014 and October 2014 at King Abdulaziz University Hospital, Jeddah, Kingdom of Saudi Arabia. A self-administered questionnaire was distributed to all participants. The response rate was 90%.

Results: One hundred sixty-two resident completed the questionnaire. Most residents were well-informed in basic concepts, such as, "*P*" values, study power, and case control studies; more than half had confidence in interpreting the results of scientific papers. Conversely, more than 67% of the residents were not knowledgeable on more sophisticated terms in biostatistics. Residents with previous training in evidence-based medicine (EBM) (p=0.05) and non-specialist residents (p=0.003) were more likely to have better knowledge scores. Females (p=0.003), and those with previous training in biostatistics and epidemiology had positive attitude toward biostatistics (p<0.001 in both cases). Residents who read medical journals scored lower than those who never read journals (p=0.001).

Conclusion: Prior courses in EBM, as well as male gender were associated with knowledge scores. Reinforcing training after graduation from medical school with special focus on integrating biostatistics with epidemiology and research methods is needed.

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Biostatistics or medical statistics are defined as the study of statistics in the context of biological science.[1] In other words, it is a branch of statistics that collects mathematical factors and data related to health, preventive medicine, and disease.[2] Biostatistics are considered to be an important element of evidence-based medicine (EBM); however, it is taught at the undergraduate level, and very little emphasis is placed on its practical aspects and applications. Consequently, after graduating from medical school, clinicians do not have in-depth knowledge of concepts in biostatistics and have to improve their knowledge.[3] In Kingdom of Saudi Arabia, medical biostatistics is included in a one-year pre-medical course that students are required to pass. In 2014, a total of 29 medical schools, 20 non-profit, and 9 private existed in Kingdom of Saudi Arabia. Approximately 6000 students enroll in these colleges annually. Little time is dedicated for teaching biostatistics and epidemiology in most of these academic institutions, further precluding students from developing an interest in research. This may be explained that while students and physicians are motivated to study medicine, they are not motivated enough to study subjects, such as, biostatistics. In addition, students vary in their interest, knowledge, and abilities in mathematics. Consequently, physicians are less productive in research and lack knowledge of statistical methods through most of their careers.[4] Students may acquire the required knowledge if they are more involved in research.[5] One of the possible reasons why medical students are not particularly knowledgeable in statistics is that it was different from other courses that are taught in medical school.[6] It is relatively easy for a medical student to read on and understand a disease, or a medical problem by himself, which is not the case for biostatistics and epidemiology subjects; where a qualified teacher is needed to teach new and unfamiliar concepts to the medical students. The main aim of this study is to assess resident physician's knowledge and attitudes toward biostatistics and research methodology.

Methods. A cross-sectional survey was conducted between November 2014 and October 2014. King Abdulaziz University Hospital, Jeddah, Kingdom of Saudi Arabia was our chosen place to conduct this study. The study population consists of all residents enrolled in the Saudi Commission for Health Specialties training programs of all levels and specialties who were graduates of 7 different medical colleges. A convenience sampling method was used to select the participants. Graduates which did not complete their internship and residents of academic affiliation as demonstrators were excluded.

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All participants were informed the nature of the research, and they gave their consent prior to inclusion. They were also informed of the confidentiality of their response. The research and ethics committee of King Abdulaziz University Hospital granted permission to conduct this research.

We used a self-administered questionnaire, which was adopted from the study by Windish et al.[3] However, in our questionnaire, we included 4 additional questions that assessed the participant's involvement in research and publishing. An e-mail permission to use the questionnaire was obtained from the corresponding author. The questionnaire focused on identifying and interpreting the results of simple statistical methods (chi-square, 't' test, and analysis of variance [ANOVA]), and multivariate analyses (Cox proportional hazards regression, and multiple logistic regression). The questionnaire was divided into the following sections: 14 demographic questions that included age, gender, current training level, prior courses in biostatistics and EBM, involvement in research activities and current journal reading practices; 5 attitude questions regarding statistics; 4 confidence questions on interpreting and assessing statistical concepts; and a 20 test questions on biostatistics and research methods, knowledge that assessed participants' understanding of statistical methods, study design, and interpretation of data with maximum score of 100 giving 5 marks for every biostatistics knowledge question.[3] The questionnaire is valid, reliable, and available online.[3]

The researchers distributed the self-administered questionnaires. Thirty minutes were given to complete it. All questionnaires were collected on the same day. The study was conducted over one month, so no contamination (information bias) occurred in the result. The key answers and feedback were given only at the end of the whole period of the study. All ethical considerations were followed according to the principles of Helsinki Declaration.

Statistical analysis. The data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS) software, IBM SPSS Statistics for Windows version 20, (IBM Corp., Armonk, New York, USA). Descriptive statistics was performed for all variables.[7] Results are expressed as frequency (%) and mean (standard deviation). The chi-square test was used to assess the association and/or difference between categorical variables, while a student 't' test was used for comparison of means of 2 continuous variables. Multiple linear regression model for covariates predicting mean knowledge scores was applied. Statistical significance was set at '$p<0.05$' 2-tail probability.

Results. Overall, 180 residents were invited to participate, of which 162 (90%) responded. Males comprised more than two-thirds of the participants, who were in most cases ≤30 years-old. Most of the respondents (93.2%) were Saudi, and over half of the participants had graduated from medical school only one-year prior to the study. The most general specialty of the physicians was internal medicine, followed by surgery. Non-specialist residents constituted less than one-tenth of the study sample. Furthermore, 40% admitted ever attending an epidemiology or biostatistics course; a similar proportion reported ever attending an EBM course and less than one-tenth of the physicians read medical journals.

Most participants were knowledgeable of basic concepts, such as, '*P*' values, study power, and case control study; over half of the respondents were also confident that they could interpret results. Conversely, more than 67% of the respondents were unfamiliar with the more sophisticated terms. Further analysis showed that females were more likely to have a positive attitude toward biostatistics ($p=0.003$; **Table 1**) and males scored more in the knowledge test regarding terms used in biostatistics ($p=0.006$; **Table 2**). In addition, non-specialist residents were more knowledgeable than physicians in other specialties ($p=0.003$) although their attitude to biostatistics did not differ significantly from those of their colleagues in other specialties. Physicians with prior training in biostatistics and epidemiology had a positive attitude toward biostatistics ($p<0.001$ in both gender). While physicians who reported ever attending an EBM course were more likely to score higher ($p=0.05$), their attitudes toward EBM courses did not differ significantly from those of their counterparts who had never attended an EBM course ($p=0.07$). Physicians who read medical journals scored lower than those who never read journals ($p=0.001$), and their attitudes toward biostatistics were not significantly different from those of their colleagues who reported never reading medical journals ($p=0.22$).Multiple linear regression analyses showed that prior courses in EBM and biostatistics, as well as male gender were associated with knowledge scores (**Table 3**).

Discussion. Our analysis showed that the resident physicians at our target population lacked the required knowledge in biostatistics to interpret most results published in the medical literature, a finding that is probably a result of insufficient training. More than half of the respondents reported that they had never had courses on biostatistics, epidemiology, or EBM

during their postgraduate medical education or training years. It is possible that even those who had biostatistics training during undergraduate education were not able to reinforce this knowledge during their career. More so, physicians were not very knowledgeable in biostatistics probably due to lack of interest in reading journals, as reflected by the high proportion of resident physicians in this study who did not read medical journals. Our finding that resident physicians were familiar with some concepts like *p*-values, interpretation of results, study power, and case control study are consistent with those of other authors.[8] WHO reported that medical

Table 1 - Attitudes toward biostatistics and research methods by participant characteristics.

Characteristic	Attitude		Chi-square	*P*-value
	Negative	Positive		
Age				0.007
≤30 years	25 (19.2)	105 (80.8)	7.28	
>30 years	0 (0.0)	32 (100)		
Gender				0.003
Male	25 (20.2)	99 (79.8)	9.06	
Female	0 (0.0)	38 (100.0)		
Nationality				0.79
Saudi	23 (15.2)	128 (84.8)	0.07	
Non-Saudi	2 (18.2)	9 (81.8)		
Years after graduation				
1	20 (19.0)	85 (81.0)		
2	5 (16.1)	26 (83.9)		
3	0 (0.0)	16 (100.0)		
4	0 (0.0)	10 (100.0)	5.81	0.12
Specialty				0.18
Family medicine	0 (0.0)	14 (100.0)		
Surgery	5 (15.2)	28 (84.8)		
Non-specialist residents	4 (36.4)	7 (63.6)	7.59	
Internal medicine	11 (19.0)	47 (81.0)		
Pediatrics	2 (9.5)	19 (90.5)		
Obs/Gyn	3 (12.0)	22 (88.0)		
Previous courses in biostatistics				<0.001
Yes	0 (0.0)	70 (100.0)	22.49	
No	25 (27.2)	67 (72.8)		
Previous course work in epidemiology				<0.001
Yes	0 (0.0)	69 (100.0)	21.93	
No	25 (26.9)	68 (73.1)		
Previous courses in EBM				0.07
Yes	7 (9.7)	65 (90.3)	3.24	
No	18 (20.0)	72 (80.0)		
Reads medical journals				0.22
Yes	25 (16.2)	129 (83.8)	1.54	
No	0 (0.0)	8 (100.0)		

Obs/Gyn - obstetrician/gynecologist, EBM - evidence-based medicine

Table 2 - Mean knowledge scores in biostatistics and research methods by participant's characteristics.

Characteristic	Knowledge		
	Mean score	t-test	*P*-value
Age			0.88
≤30 years	23.75	-0.15	
>30 years	24.06		
Gender			0.006
Male	25.00	2.77	
Female	19.86		
Nationality			0.25
Saudi	24.07	1.15	
Non-Saudi	20.45		
Years after graduation			0.25
1	23.13		
2	27.09	1.39	
3	23.13		
4	22.00		
Specialty			0.003
Family medicine	20.36		
Surgery	22.03		
Non-specialist residents	35.45	3.85	
Internal medicine	23.45		
Pediatrics	22.86		
Obs/Gyn	24.60		
Previous courses in biostatistics			0.83
Yes	23.62	-0.21	
No	23.97		
Previous course work in epidemiology			0.94
Yes	23.75	-0.08	
No	23.87		
Previous courses in EBM			0.05
Yes	25.56	1.96	
No	22.44		
Reads medical journals			0.001
Yes	23.09	-3.34	
No	32.92		

Obs/Gyn - obstetrician/gynecologist, EBM - evidence-based medicine

Table 3 - Multiple linear regression model for covariates predicting mean knowledge scores in biostatistics and research methods.

Covariant	β	t-test	*P*-value
Gender*	-4.75	-2.70	0.008
Age	-0.84	-0.36	0.720
Nationality	-0.79	-0.25	0.800
Specialty	-4.05	-1.56	0.120
Years after graduation	-3.68	-1.88	0.060
Previous courses in epidemiology	6.07	1.88	0.060
Previous courses in biostatistics†	7.04	2.28	0.030
Previous courses in evidence-based medicine‡	-13.94	-4.65	<0.001
Reads medical journals	5.05	1.40	0.150

r^2=0.24. *0 - male, 1 - female, †0 - yes, 1 - no, ‡0 - yes, 1-no

students were familiar with general terminologies, such as, *p*-values and chi-square tests. Conversely, the respondents in our study were unfamiliar with more advanced concepts, such as, ANOVA, sample size, and odds ratio, which is not surprising given that at the postgraduate level, few continuing education courses are offered and physicians are not encouraged to actively participate in research. In this study, knowledge and positive attitude were highly associated with gender; males having better mean scores, which may be due to segregated gender specific teaching in early years of medical college. Contrary to our findings, other authors found that knowledge and skills in evidence-based practice were rarely associated with gender.[9]

Respondents who had previous courses in EBM had significantly higher knowledge scores than their counterparts. In addition, we found a strong association between previous courses in epidemiology and biostatistics, and the overall positive opinion of physicians toward the importance of research. On the other hand, previous courses in EBM and journal reading practices did not affect the opinion of the respondents. Previous courses in EBM, male gender were important predictors for high knowledge scores. A similar result was reported in a prior study where 5 predictors of knowledge scores were identified, that is prior biostatistics training, advanced degrees, gender, and years since medical school graduation.[3] Residents with previous courses in biostatistics scored less in the knowledge test. This goes with a similar result in a study that suggested that independent courses in biostatistics are unlikely to rectify clinicians' research abilities and skills.[5] In contrast, the integrating approach of biostatistics with epidemiology and research methods will positively affect clinicians' research abilities and patient care decisions.[10,11]

Specialty was significantly associated with knowledge scores, with non-specialist residents showing the best scores amongst others. This might be probably as non-specialist residents experience greater pressure, as they have a wider spectrum of cases to manage, which prompts them to keep abreast with current medical knowledge. A similar result was reported in a previous study, where senior residents performed worse than junior physicians. The author suggested that this finding was possibly due to loss of knowledge over time, lack of reinforcement, or both.[3] This study highlights the importance of integrating biostatistics, epidemiology and EBM courses throughout the years of education. Residents should be encouraged to enroll in biostatistics or epidemiology courses and perform several researches. In addition, there should be an accredited guideline aimed at helping residents to conduct researches properly. However, challenges should be expected, as a recent systematic review proved the complexity of applying such programs and the limited effectiveness of many journal clubs and EBM curricula.[12] This highlights the importance of planning and implementing new interactive, integrated, and self-directed policies,[13] Such as integrating effective multi-task researches during educational years to encourage physicians to read medical journals regularly. For example, the scientific committees of different specialties in the Saudi commission for health specialties can implement an effective strategy during training years by encouraging residents to conduct a research after introducing courses in biostatistics, epidemiology, and research methods, which only few specialties do. Unfortunately, current practices do not motivate residents to enhance their knowledge in biostatistics and EBM, especially after they graduate from medical school.[14]

The limitation of the study conducted using a convenience non-probability sampling method in a single training center, which does not permit us to generalize our results.

In conclusion, prior courses in EBM as well as male gender were associated with knowledge scores. Besides the fact that knowledge in biostatistics is crucial in the early stages of medical education, it should be continuous throughout a physician's medical career. Training should therefore be reinforced even after graduation from medical school. Given the importance of statistical methods in research, we recommend that more focus be placed on integrating biostatistics and epidemiology, with special consideration on the practical aspects of research, which is the essence of standard patient care. Further studies are needed to investigate the finding of higher knowledge score in biostatistics and research method in male resident physicians, if any.

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