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Determining Biostatistics Knowledge of Students and Physicians in Medical School

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Abstract:

The aim of this study is to determine statistics knowledge of physicians and students according to their major branches and statutes and find out their thoughts on the importance they give to the biostatistics education and finally decide at which semester the biostatistics education should be given.

The questionnaire was applied to 498 undergraduate students, 103 resident physicians and 94 academic staff in Medical School.

According to the data, the first choice of the students and the residents is that the biostatistics education should be given at the beginning of the residency. It is seen that there is a correlation between being agree with biostatistics is useful for career and being agree with biostatistics is very important for medicine science. Our results indicate that there is no significant difference on the level of the statistics knowledge between the undergraduate students and the resident physicians. Residents, who are involved in the researches gain increment both on knowledge of general statistics and tests such as non-parametric statistics and sampling techniques. Also another surprising result has been discovered that sampling knowledge of the academic staff is quite insufficient.

In the light of those findings, we believe that great importance should be given to the biostatistics education so that the biostatistics education will improve physician's analytical thinking ability, understanding and interpreting statistical results in medical studies. Hence they will manage to use statistics properly.

Key Words: Biostatistics Education, Medical Students, Physician, Biostatistics Curriculum, Biostatistics Course

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1. INTRODUCTION

Biostatistics is an applied science for biology, medical and health sciences (1). Biostatistics has been recognized as a discipline since less than 60 years and the growth of science is observed with the growth of systematic medical research in the United Kingdom and United States in the late 1940s (2).

The establishment of Biostatistics as a department in Turkey began at early 1980s. Before then the biostatisticians were working under the public health department. Today, there are 19 Biostatistics Departments among 44 Medical Schools in Turkey. Biostatistics is usually thought as an obligatory course in the 1st year. Unfortunately at the medical schools without Biostatistics Departments, the course is taught by the instructors who are not biostatisticians and consulting is provided by non-biostatisticians.

It is a common idea that there are some serious difficulties in the biostatistics education. Some reasons of that are as follows: while students and physicians are very well motivated about study of medicine, in minor branch of basic sciences, they are not well motivated enough about studying of statistics. In addition to that there is a wide variety on mathematics knowledge, ability and interest among the students (3). That kind of difficulties cause the reduction of productivity and permanency of the statistics knowledge.

Many biostatisticians have been witnessed that during the statistical consultancy many physicians claim that they didn't give enough importance on statistics when they were students. Hence from the beginning of the undergraduate education, at which semester and semesters the biostatistics education should be given to the medicine students and physicians is an important question. As undergraduates their main aim is to pass the course, but for physicians embarking on their own research, even if only temporarily, the motivation is to obtain sufficient understanding of basic statistical methodology. The depth of knowledge that they will require may not be apparent initially but will increase the longer they stay in research (4). It is well known that undergraduate courses in medical statistics are not particularly popular among the students. There are several possible reasons for this. As Altman pointed out that statistics is a very different subject from those on which the students spend most of their time (4).

Another consideration for us is to decide which statistical methods are mostly needed for the students, physicians and academics. Hence the main aim of this study is to focus on which subjects of statistics the students and the physicians should have proficiency according to their statutes and major branches of medicine (basic, internal and surgical) and also find out the importance they give to the biostatistics. Clearly, these findings will help us to decide at which semester of medical education the biostatistics education should be given.

2. MATERIALS AND METHODS

The questionnaire is responded by 498 undergraduate students (1st year: 224, 2nd year: 93, 3rd year: 51, 4th year: 54, 5th year: 22, and 6th year: 54); 103 resident physicians, 94 academic staff (20 specialist physicians, 23 assistant professors, 26 associate professors, 25 professors) in Uludag University, Medical School in Turkey. At the first part of the questionnaire 4 questions were asked: The subjects were asked if they think that either the biostatistics course is useful or not for their career in the future (completely disagree: 0 – completely agree: 4), at which semester or semesters the biostatistics education should be given, also they were asked how much importance they gave to the biostatistics (not important: 0 – very important: 10), and finally if the students or residents had worked in a research on health.

At the other part of the questionnaire the subjects were asked which statistics methods, tests and techniques among 54 different tests they know. The subjects weren't asked about their complete knowledge on methods, tests and techniques, but only their general knowledge about these methods, tests and techniques. In the questionnaire methods, tests and techniques are grouped as "general statistics knowledge", the topics thought in undergraduate course is defined as "the topics included by curriculum" and the subjects that are not thought in undergraduate course are classified as "the topics out of curriculum", "parametric tests" and "non-parametric tests", "multivariate methods", "sampling methods" and "survival analysis methods". The statistics knowledge of each subject is obtained as a ratio by dividing the number of methods, tests and techniques to the total number of methods, tests and techniques in that group. The medicine students were not taken into account for evaluating the knowledge on "the all methods, tests and techniques", "the topics aren't thought in undergraduate courses", "multivariate analysis subjects" and "survival analysis methods". The second part of the questionnaire was not applied to the 1st year students since they had just taken the biostatistics course.

Another part of the questionnaire in our study was prepared to decide the course hours, applications and the curriculum of these courses. The question on "the topics included by the curriculum" and "the topics that are out of the curriculum" are applied by taking account the common courses that are thought in biostatistics at the medical schools.

In this study, Shapiro-Wilk and Kolmogorov-Smirnov Lilliefors normality tests were applied in order to check if the values of the variables are normally distributed. The variables had not shown normal distribution. For comparison Kruskal-Wallis tests and Mann-Whitney U test were applied with significance level of α=0.05. The correlations among the variables were examined by Spearman Rank Correlation

Coefficient. After post-hoc comparisons, Bonferroni correction was applied and then the new resulting significance level ($\alpha^{*}=1-(1-\alpha)^{1/k}$ k: number of groups) was taken into account.

The median, first quartile (Q1) and third quartile (Q3) values of statistics knowledge describe the known test ratio for the related subject.

3. RESULTS AND DISCUSSION

The increment of knowledge with the improvement of the tools used for obtaining knowledge and the complex structure of the knowledge require the necessity for the analysis of the data and we know that is only provided by statistics (5). With that development as mentioned by Sahai and Ojeda (1) physicians and other staff interested in medicine notice that they need biostatistics principles and methods. Over the past decades, the use of statistics in medical journals has increased both in quantity and in sophistication (6, 7). The development of statistical software and computer are parallel with that improvement (8). Although disadvantage of this development is not often recognized by consumer of research; the statistical errors are so common that is believed that almost 50% of medical literature has statistical errors (4). Hence the importance given to the biostatistics education continuous to increase.

With the increment of importance given to biostatistics education it is important to know the thoughts about the usefulness of biostatistics courses and the importance in medicine science by their statutes. In addition to this, it is important to know the level of statistics knowledge in order to solve the problems that occur during biostatistics education and also it is important for planning of curriculum for both undergraduate and graduate education.

Biostatistics course in Medical Schools in Turkey is obligatory for undergraduate education, but for residency, it is not obligatory. The Biostatistics course hours per semester in Turkey in medical schools change between 22 and 100 hours, with 60 hours mean (standard error of mean: 5.61). In 66.60% of these medical schools applied courses are also given. The application course hours change between 4 and 45 hours with 22 hours mean (SEM:3.77). The ratio for application is 33.83% (SEM:3.83, min: 16.67 and max: 50.00). Education is given by computers 55.5% of these faculties and the number of students per computer is 1.70 (0.21, 1-3).

Biostatistics courses in medical schools in Turkey change both in course hours and curriculum of the courses (Table-1). In most medical schools application is made by computers. However differences can be seen country by country also faculty by faculty (1, 9).

Table-1: The curriculum of Biostatistics Departments that are in School of Medicine in Turkey

Curriculum topics that are common	Curriculum topics that are not common
Definitions and terms	Statistical methods in medical
Ways of data collecting	Survival analysis
Summarize the data	Diagnostic tests
Graphs	ROC analysis
Means	Hospital statistics
Measures of distribution	Power analysis
Sampling	Clinical decision making methods
Probability	Time series analysis
Binomial distribution and its probability	Statistics related with the population
Poisson distribution and its probability	Criterion identifying health level
Hypothesis	Lists classifying diseases
Normal distribution	
t distribution	
Chi-square distribution	
Non-parametric tests	
Regression	
Correlation	
Analysis of variance	
Birth rate, mortality, morbidity	
Writing report	

61.90% of undergraduate students (299/483), 54.46% of resident physicians (55/101), and 75.53% of academic staff (71/94) agreed the biostatistics course should be taken during undergraduate education. However the choices of academic staff are different from the choices of students and residents ($p<0.05$, $p<0.01$).

54.04% of undergraduate students (261/483), 86.14% of residents (87/101), and 96.81% of academic staff (91/94) think that the biostatistics education should be taken during the residency. There are significant differences among three groups (undergraduate students- residents $p<0.001$, students-academic staff $p<0.001$, and residents-academic staff $p<0.01$).

From the beginning of undergraduate education until the end of the residency, the first choice of the students and the residents is that the biostatistics education should be given at the beginning of the residency, and should be given at the first year of the undergraduate study and the beginning of the residency for the academic staff (Table-2).

The belief that biostatistics education is necessary is more common among the academic staff than the students and the residents. Belief that taking the biostatistics during the residency is differ among the students, the residents and the academic staff. That belief increases with the increase in statute.

Table-2: The distribution of choices for the length of biostatistics course for undergrads, residents and academic staff*.

Student (n=483)			Resident (n=101)			Academic Staff (n=94)		
Class	**%**	**n**	**Class**	**%**	**n**	**Class**	**%**	**n**
At the beginning of residency	24.22	117	**At the beginning of residency**	25.74	26	**1st class and at the beginning of residency**	11.70	11
6th class	17.81	86	**Middle of residency**	9.90	10	**At the beginning of residency**	10.64	10
1st class	11.80	57	**6th class and at the beginning of residency**	7.92	8	**Middle of residency**	10.64	10
At the end of residency	9.11	44	**1st class and at the beginning of residency**	5.94	6	**2nd class and at the beginning of residency**	7.45	7
5th class	5.18	25	**At the end of residency**	5.94	6	**5th class and at the beginning of residency**	6.38	6
						6th class and at the beginning of residency	5.32	5
Other	31.88	154	**Other**	44.56	45	**Other**	47.87	45

*The cells that are chosen less than 5% are not given

According to the results of our study, students of medical school do not believe that biostatistics education provides an additional benefit for their occupational career. But the academic staff believes that biostatistics courses certainly provide an additional benefit for their career. The thoughts of the residents on that issue lies between that two groups. Believing on benefits of biostatistics course gets more common with higher position of the statute (Table-3). As mentioned by Sahai and Ojeda (3) one reason why they don't believe the additional benefit of biostatistics course is, students of medical school do not plan academic career for the future. Even if they plan academic career they do not notice the importance of the biostatistics course at the beginning of their study.

Table-3: The descriptive values and comparisons of the belief on taking biostatistics course is useful for occupation and the importance given in medicine science according to the statutes

statute	Do you agree with the idea that taking biostatistics course of a physician is useful for his/her occupation? (min-max:0-4)				What is the importance of biostatistics in medicine science? (min-max:0-10)			
	n	Median	Q1	Q3	n	Median	Q1	Q3
1st class (1)	222	1.00	1	2	217	5.00	3	7
2nd class (2)	91	1.00	1	2	92	5.00	2	7
3rd class (3)	51	1.00	1	2	51	4.00	3	7
4th class (4)	54	1.00	1	2	53	5.00	2	8
5th class (5)	22	1.00	1	2	22	5.00	4	8
6th class (6)	54	1.00	1	2	54	5.00	3	7
Resident (7)	102	2.00	2	4	102	8.00	7	10
Specialist(8)	20	4.00	3	4	20	10.00	8	10
Assistant Professor (9)	23	4.00	2	4	23	9.00	8	10
Associate Professor (10)	26	4.00	3	4	26	9.00	8	10
Professor (11)	25	4.00	3	4	25	10.00	8	10
p value (α=0.05)		<0.001				<0.001		
Post Hoc Results (α*=0.005)		**1**-7,8,9,10,11 **2**-7,8,9,10,11 **3**-7,8,9,10,11 **4**-7,8,9,10,11 **5**-7,8,9,10,11 **6**-7,8,9,10,11 **7**- 8,10,11				**1**-7,8,9,10,11 **2**-7,8,9,10,11 **3**-7,8,9,10,11 **4**-7,8,9,10,11 **5**-7,8,9,10,11 **6**-7,8,9,10,11		

When we evaluate the results according to the general areas of medicine, being agree on the belief of necessity of taking biostatistics course is high for basic, internal and surgical medicine physicians and they don't have any disagreement (Table-4). The belief of necessity of taking that course is higher among internal and surgical specialists than the residents. There is no difference about thoughts among the basic medicine physicians according to their statutes (Table-5).

Table-4: The descriptive values and comparisons of the belief on taking biostatistics course is useful for occupation and the importance given in medicine science according to basic, internal, surgical physicians

	Do you agree with the idea that taking biostatistics course of a physician is useful for his/her occupation? (min-max:0-4)				What is the importance of biostatistics in medicine science? (min-max:0-10)			
	n	Median	Q1	Q3	n	Median	Q1	Q3
Basic Sciences	35	4.00	2.00	4.00	36	9.00	8.00	10.00
Internal Sciences	101	4.00	2.00	4.00	100	9.00	8.00	10.00
Surgical Sciences	60	3.00	2.00	4.00	60	8.00	6.00	10.00
p value (α=0.05)		0.055				0.003		
Post Hoc Results (α*=0.017)						Surgical -Basic $p<\alpha^{*}=0.017$ Surgical -Internal $p<\alpha^{*}=0.017$		

Table- 5: The descriptive values and comparisons of the belief on taking biostatistics course is useful for occupation and the importance given in medicine science according to residents and academic staff in basic, internal and surgical sciences

		Do you agree with the idea that taking biostatistics course of a physician is useful for his/her occupation? (min-max:0-4)				What is the importance of biostatistics in medicine science? (min-max:0-10)			
		n	Median	Q1	Q3	n	Median	Q1	Q3
Basic Sciences	Resident	11	4.00	2.00	4.00	12	10.00	8.25	10.00
	Academic Staff	24	4.00	3.00	4.00	24	8.50	7.25	10.00
	p value		0.740				0.280		
Internal Sciences	Resident	57	3.00	2.00	4.00	56	8.00	7.00	10.00
	Academic Staff	44	4.00	3.25	4.00	44	10.00	9.00	10.00
	p value		<0.001				<0.001		
Surgical Sciences	Resident	34	2.00	2.00	3.00	34	7.50	4.75	8.25
	Academic Staff	26	4.00	2.00	4.00	26	8.50	7.00	10.00
	p value		0.001				0.007		

The belief that the biostatistics course provides additional benefit on their career is lower as expected among the student who worked in a health research than students who have never worked in that kind of research. For residents, this belief is more common among the participants of a research on health (Table-6).

Table-6: The descriptive values and comparisons of the belief on taking biostatistics course is useful for occupation and the importance given in medicine science according to the students' and residents' participating in a research

		Do you agree with the idea that taking biostatistics course of a physician is useful for his/her occupation? (min-max:0-4)				What is the importance of biostatistics in medicine science? (min-max:0-10)			
		n	Median	Q1	Q3	n	Median	Q1	Q3
Student	Participate in a research	80	1.00	1.00	2.00	81	5.00	3.00	7.00
	Not participate in a research	408	1.00	1.00	2.00	404	5.00	3.00	7.00
	p value		0.932				0.995		
Resident	Participate in a research	83	3.00	2.00	4.00	82	8.00	7.00	10.00
	Not participate in a research	19	2.00	1.00	2.00	19	7.00	4.00	8.00
	p value		0.005				0.005		

According to the results of our study, when the thoughts of the students and the physicians on the importance of biostatistics for medicine are compared, there are differences among the students, residents and academic staff. While the students of medicine give medium importance, physicians give higher importance.

When it is examined according to different areas of medicine, basic, internal and surgical physicians believe that the biostatistics has a great importance for medicine. But this belief is higher for basic and internal physicians than the surgical physicians (Table-4). For the academic staff, this belief is higher than the residents among the internal and surgical physicians. But for basic science physicians, there is no difference among the residents and the physicians (Table-5).

On the other hand there is no difference between the thoughts of the students who worked in a medical research and who have never worked in a medical research. But the residents who worked in a research give more importance to the biostatistics than the residents who have never worked in a research (Table-6).

There is a correlation between being agreed on biostatistics as a course provides additional benefit and biostatistics as a science provides an additional benefit to medicine science ($r=0.673$; $p<0,001$). Hence the importance of biostatistics should be perfectly explained to the students. In order to provide this, as mentioned by Sahai and Ojeda (3) the biostatistics instructor should seek the direct classroom participation of a physician who could attest to the relevance of biostatistics to medical research and practice. One of the best ways of motivating the students to take the study of statistics seriously is to give examples of proper uses and the misuses of statistics from the medical literature (3). Hence the students will find an opportunity of understanding the importance of biostatistics in medicine science and that will help an increase on the belief that biostatistics course provides an additional benefit on their career; as a result effort on the course will increase.

When the levels of knowledge are compared (the students were not asked to join that part of the study), the statistics knowledge of residents are lower than the academic staff for general statistics topics. But for survival analysis, only the specialists' statistics knowledge is higher than the residents. For the subjects that are out of curriculum, the residents' statistics knowledge is lower than the specialists and the associate professors. For multivariate methods, the statistics knowledge of the physicians is lower than for the other statistics subjects and there is no difference between the residents and the academic staff (Table-7).

Table-7: The descriptive values and comparisons of the level of knowledge on statistics subjects according to the statutes

Statute		Statistics subjects							
		Sampling methods S1 (%)	Parametric tests S2 (%)	Non-parametric tests S3 (%)	Topics included by curriculum S4 (%)	Topics out of curriculum S5 (%)	Multivariate methods S6 (%)	Survival analysis methods S7 (%)	General Statistics S8 (%)
2nd Year	Median	0.00	28.57	7.14	16.00	-	-	-	-
n=93 (2)	Q1	0.00	0.00	0.00	0.00				
	Q3	25.00	57.14	28.57	52.00				
3rd Year	Median	8.33	14.29	7.14	20.00	-	-	-	-
n=51 (3)	Q1	0.00	0.00	0.00	0.00				
	Q3	41.67	28.57	14.29	36.00				
4th Year	Median	0.00	14.29	7.14	12.00	-	-	-	-
n=54 (4)	Q1	0.00	0.00	0.00	0.00				
	Q3	16.67	28.57	16.29	20.00				
5th Year	Median Q1	0.00	7.14	7.14	14.00	-	-	-	-
n=22 (5)	Q3	0.00	0.00	0.00	3.00				
		25.00	17.86	8.93	22.00				
6th Year	Median	8.33	14.29	7.14	12.00	-	-	-	-
n=54 (6)	Q1	0.00	0.00	0.00	4.00				
	Q3	25.00	14.29	14.29	24.00				
Resident	Median	0.00	0.00	7.14	8.00	3.70	0.00	0.00	5.56
n=103 (7)	Q1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Q3	0.00	28.57	14.29	20.00	7.41	0.00	33.33	12.96
Specialist	Median	0.00	42.86	39.29	34.00	9.26	0.00	33.33	22.22
n=20 (8)	Q1	0.00	14.29	16.07	11.00	0.00	0.00	0.00	6.94
	Q3	8.33	82.14	50.00	52.00	21.30	14.58	58.33	33.33
Assistant	Median	0.00	28.57	28.57	28.00	7.41	0.00	0.00	14.81
Professor	Q1	0.00	14.29	14.29	20.00	0.00	0.00	0.00	11.11
n=23 (9)	Q3	8.33	71.43	35.71	36.00	14.81	8.33	66.67	27.78
Associate	Median	0.00	57.14	35.71	32.00	7.41	0.00	0.00	22.22
Professor	Q1	0.00	28.57	19.64	20.00	0.00	0.00	0.00	11.11
n=26 (10)	Q3	10.42	85.71	50.00	53.00	15.74	8.33	66.67	31.94
Professor	Median	0.00	42.86	14.29	20.00	3.70	0	0.00	11.11
n=25 (11)	Q1	0.00	14.29	7.14	16.00	0.00	0.00	0.00	7.41
	Q3	4.17	71.43	32.14	40.00	7.41	8.33	16.67	22.22
p value (α=0.05)		<0.001	<0.001	<0.001	<0.001	0.004	0.063	0.031	<0.001
S1 (α*=0.005)	**3**-7,9,11; **6**-7								
S2 (α*=0.005)	**2**-7,10; **3**-9,10,11; **4**-8,9,10,11 ;**5**-8,9,10,11; **6**-8,9,10,11; **7**-8,9,10,11								
S3 (α*=0.005)	**2**-8,9,10; **3**-8,9,10,11; **4**-8,9,10,11 ;**5**-8,9,10,11; **6**-8,9,10,11; **7**-8,9,10,11								
S4 (α*=0.005)	**3**-10; **4**-8,9,10,11 ;**5**-8,9,10; **6**-8,9,10,11; **7**-8,9,10,11								
S5 (α*=0.010)	**7**-8,10								
S7 (α*=0.010)	**7**-8								
S8 (α*=0.010)	**7**-8,9,10,11								

It is seen that the statistics knowledge of residents is insufficient. Hence a general biostatistics that build up their knowledge should be given to residents at the beginning of the study.

Multivariate statistical methods are not sufficiently known by the physicians. These methods need advanced mathematical basis and the use of them needs proficiency. In our study the subjects weren't asked if they have complete knowledge about the test, only their general knowledge about the test and the aim of using that test were asked. Hence the physicians may find their statistics knowledge sufficient and they may not consult a

statistician. That may lead them to use univariate techniques instead of the one that must be used. Therefore, we believe that it is essential to give general information about the aims of use of multivariate statistical methods.

The statistics knowledge is compared with each other by taking account the topics included by the curriculum; parametric tests, non-parametric tests and sampling methods. Also the students joined to this part of the study. Results indicate that the statistics knowledge of the students is lower than the academic staff for parametric tests, non-parametric tests and the topics included by curriculum. This result is even valid for the 2^{nd} year students who took the biostatistics course in the previous year. But the result for sampling methods is vice-versa. The level of sampling knowledge of 3^{rd} year students is higher than the residents, assistant professors, and professors. The statistics knowledge of the 6^{th} year students is higher than the residents (Table-7).

It is common idea that students intend to forget the knowledge they learned in biostatistics course soon after the course. The reasons of that are they do not apply the knowledge they had and they do not follow the medical literature during undergraduate study. Of course these reasons are related with the teaching methodology, furthermore they do not believe the additional benefit of the biostatistics course to their career as mentioned above.

After this evaluation another issue that must be taken into account is the sampling methods that should especially be thought to the academic staff. While academic staff's sampling knowledge of statistics is higher than the students, it is an unexpected result that they are poor in sampling. Actually students' statistics knowledge is not higher for sampling methods than the any other topics. The academic staffs' statistics knowledge is lower for sampling methods than the other topics (Table-7). The academic staff needs to have statistical tests in order to get the results, but there is not an obligatory reason to learn sampling method. Hence they do not have enough motivation to learn these methods. Our results indicate that the sampling knowledge of academic staff is quite poor.

There is no significant difference among basic, internal and surgical physicians by their general statistics, multivariate methods, non-parametric tests, sampling methods and topics out of curriculum, but there is significant difference for parametric tests, survival analysis methods and topics included by curriculum. The level of knowledge is higher for the basic science physicians than the internal physicians for the topics included by curriculum and parametric tests. As expected, statistical ability for survival analysis is higher for the internal physicians than the basic science physicians (Table-8).

Table-8: The descriptive values and comparisons of the level of knowledge on statistics subjects according to the physicians in basic, internal and surgical sciences

		Sampling methods (%)	Parametric tests (%)	Non-parametric tests (%)	Topics included by curriculum (%)	Topics out of curriculum (%)	Multivariate methods (%)	Survival analysis methods (%)	General Statistics (%)
Basic Sciences n=36	Median	0.00	42.86	17.86	24.00	3.70	0.00	0.00	12.96
	Q1	0.00	17.86	7.14	13.00	0.00	0.00	0.00	7.41
	Q3	14.58	71.43	42.86	44.00	7.41	8.33	0.00	23.61
Internal Sciences n=101	Median	0.00	14.29	14.29	16.0	3.70	0.00	0.00	9.26
	Q1	0.00	0.00	7.14	4.00	0.00	0.00	0.00	3.70
	Q3	8.33	42.86	28.57	32.00	11.11	8.33	33.33	22.22
Surgical Sciences n=60	Median	0.00	14.29	17.86	20.00	0.00	0.00	0.00	9.26
	Q1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Q3	0.00	57.14	35.71	32.00	11.11	0.00	33.33	22.69
	p value α=0.05	0.139	0.004	0.239	0.033	0.321	0.493	0.026	0.136
Post Hoc Results (α^*=0.017)			Basic-Internal $p<\alpha^*=0.017$		Basic-Internal $p<\alpha^*=0.017$			Basic-Internal $p<\alpha^*=0.017$	

The statistics knowledge of basic science residency students is lower than the academic staff for parametric tests and the topics included by curriculum. However there is not a significant difference between the two groups for general statistics knowledge, multivariate statistical methods, non-parametric tests, survival analysis methods, sampling methods and the topics that are out of the curriculum (Table-9)

The internal residency students' level of knowledge is lower than the academic staff for general statistics knowledge, multivariate statistical methods, parametric tests, non-parametric tests, survival analysis methods, the topics included by curriculum and out of curriculum. On the other hand there is no significant difference between two groups for sampling methods (Table-9).

The statistics knowledge of surgical residents is lower than the academic staff for general statistics knowledge, parametric tests, non-parametric tests and the topics included by curriculum. There is not a significant difference between the two groups for multivariate methods, survival analysis methods, sampling methods, and the topics out of the curriculum (Table-9).

The biggest difference for level of knowledge between basic, internal, surgical residents and academic staff for different topics of statistics is seen in internal physicians and the smallest difference is seen in basic science physicians. Hence more detailed biostatistics courses can be given internal residents than the others. There isn't a significant difference according to the statistics knowledge of three medical sciences' residents and academic staff for sampling methods. It is seen that the level of knowledge of basic, internal and surgical physicians is

quite low for sampling methods (Table-9). Therefore more importance should be given to sampling methods in biostatistics courses..

Table-9: The descriptive values and comparisons of the level of knowledge on statistics subjects according to the residents in basic, internal and surgical sciences

			Sampling methods (%)	Parametric tests (%)	Non-parametric tests (%)	Topics included by curriculum (%)	Topics out of curriculum (%)	Multivariate methods (%)	Survival analysis methods (%)	General Statistics (%)
Basic Sciences	Resident n=12	Median	0.00	21.43	14.29	14.00	3.70	0.00	0.00	9.26
		Q1	0.00	0.00	1.79	5.00	0.00	0.00	0.00	3.70
		Q3	0.00	50.00	32.14	35.00	10.19	14.58	0.00	20.37
	Academic Staff n=24	Median	0.00	57.14	28.57	26.00	3.70	0.00	0.00	14.81
		Q1	0.00	28.57	7.14	17.00	0.00	0.00	0.00	8.33
		Q3	16.67	82.14	42.86	48.00	7.41	8.33	0.00	27.31
	p value		0.199	0.011	0.265	0.038	0.804	0.704	0.960	0.062
Internal Sciences	Resident n=57	Median	0.00	0.00	7.14	8.00	3.70	0.00	0.00	5.56
		Q1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.85
		Q3	16.67	14.29	14.29	16.00	7.41	0.00	33.33	11.11
	Academic Staff n=44	Median	0.00	28.57	28.57	28.00	9.30	4.17	33.33	16.67
		Q1	0.00	14.29	14.29	16.00	3.70	0.00	0.00	7.87
		Q3	0.00	71.43	42.86	42.00	17.59	8.33	86.67	29.17
	p value		0.191	<0.001	<0.001	<0.001	<0.001	0.002	0.001	<0.001
Surgical Sciences	Resident n=34	Median	0.00	0.00	0.00	6.00	0.00	0.00	0.00	2.78
		Q1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Q3	0.00	28.57	28.43	20.00	7.41	0.00	33.33	12.96
	Academic Staff n=26	Median	0.00	42.86	28.57	30.00	3.70	0.00	0.00	17.59
		Q1	0.00	25.00	19.64	20.00	0.00	0.00	0.00	9.26
		Q3	8.33	75.00	50.00	49.00	12.04	10.42	33.33	30.56
	p value		0.203	<0.001	<0.001	<0.001	0.069	0.348	0.637	<0.001

In our study the benefit of participating in a research on medical subjects to knowledge of statistics is also examined. The level of knowledge of students who had worked in a research for non-parametric tests, sampling methods and the topics out of curriculum is higher than the ones who hadn't worked in such research. However there isn't a significant difference between the two groups for parametric tests. The level of knowledge of the residents who had worked in a research is higher than the ones who hadn't worked in such research for general statistics knowledge, non-parametric tests, sampling methods, and the topics included by the curriculum. There isn't a significant difference between the two groups for multivariate methods, parametric tests, survival analysis methods and the topics out of the curriculum. Clearly participating in research provides an increment in the level of knowledge of statistics, especially for non-parametric tests and sampling methods (Table-10).

Table-10: The descriptive values and comparisons of the level of knowledge on statistics subjects according to students' and residents' participating in a research

			Sampling methods (%)	Parametric tests (%)	Non-parametric tests (%)	Topics included by curriculum (%)	Topics out of curriculum (%)	Multivariate methods (%)	Survival analysis methods (%)	General Statistics (%)
Student	Participate in a research n=64	Median	8.33	14.29	7.14	18.00	-	-	-	-
		Q1	0.00	14.29	7.14	8.00				
		Q3	33.33	28.57	14.29	32.00				
	Not participate in a research n=207	Median	0.00	14.290	7.14	12	-	-	-	-
		Q1	0.00	.00	0.00	0.00				
		Q3	25.00	42.86	14.29	32.00				
	p value		0.031	0.241	0.046	0.042	-	-	-	-
Resident	Participate in a research n=83	Median	0.00	0.00	7.14	12.00	3.70	0.00	0.00	2.31
		Q1	0.00	0.00	0.00	4.00	0.00	0.00	0.00	5.56
		Q3	8.33	28.57	21.43	24.00	7.41	0.00	33.33	12.96
	Not participate in a research n=19	Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Q1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Q3	0.00	0.00	0.00	8.00	3.70	0.00	0.00	3.70
	p value		0.034	0.059	0.001	<0.001	0.068	0.300	0.094	0.001

It is natural that the students can face with some difficulties and problems during the biostatistics education. Some of them are as follows: while students of medical school are very well motivated for study of medicine, they might be motivated little or even not motivated for study of statistics (3). Because they are highly focused on learning the diseases and how to treat them, it is hard to switch their attention to the statistics. Hence the knowledge which is given in biostatistics course isn't permanent. As a result of our study, it is seen that even the next year after the biostatistics education statistics ability starts decreasing.

Another difficulty for the biostatistics education is the variability in mathematics ability among the students of medical school (3). That can be frustrated for the instructor since he/she faces a heterogeneous group. It can be expected that when the theoretical details are given to the students, the ones who are poor in mathematics can be bored easily and their motivation may decrease very rapidly.

Another problem is about the length of biostatistics course. Limited time for education of biostatistics prevents becoming the owner of detailed knowledge about the subjects of modern statistics (3). In our study it is seen that the participants have low level of knowledge especially on the subjects of modern biostatistics, which include multivariate analysis and subjects that are out of curriculum of statistics.

When the statistics knowledge of resident students is compared with the level of knowledge of undergraduate students, it is seen that there isn't significant difference between the two groups. Cheatham (10) mentions that the residents don't receive sufficient education for statistics theory and study design for effectively applying and interpreting the medical literature to the patient care. A survey of 62 surgical residency programs identified that only 33 percent include formal statistics teaching in their curricula (10).

In Turkey there isn't any obligation for courses of biostatistics in programs of residency whereas the physicians who study their specialties work actively in the stage of data collection in a research. Therefore the biostatistics course should be given in residency education programs and the items of the course should consist of predominantly general statistics, research methods and special knowledge of statistics that intended for their studies.

Solving problems during undergraduate studies or residency will help to increase their statistics level as academicians in the future. Since the residents give much more importance to the biostatistics than the students, solving this problem is more possible during residency. However the residents don't differ from the students for the level of statistics knowledge.

It is commonly shared idea that people in medical science should have solid background in biostatistics. Our results indicate that students, physicians and academics have different statistics level in different areas. That result does not surprise us in the sense that everyone needs different proficiency in different areas.

By considering the time and effort people spend on learning new things we recommend medical people to join the workshops that will help them to deal with the problem they face in their field. For this aim, workshops can be prepared for the people who are in basic, internal and surgical sciences.

As we mentioned above, statistics have broad application and different proficiency needed for different areas in medicine. For this reason we think that subgroups of those sciences might be very helpful for the workshops. For example, although psychiatry and medical oncology are both in internal sciences, they use different statistical methods in their studies. While psychiatrist use mostly tests for measurement reliability and validity, medical oncologists use mostly survival methods in their studies. Clearly what to include in those workshops need cooperation both from biostatisticians and the people who join the workshops. No wonder that cooperation will increase the beneficiary of the workshops.

We strongly emphasize that even if the biostatistics education given perfectly, physicians shouldn't think that the consultancy from a biostatistician is unnecessary. Biostatistics is different expertise and the biostatistics knowledge will help to physician in following the literature, finding out the points that they should be careful at

the stage of design of experiment. On the other hand analyzing the data is not very complex. One of the most common mistakes among the physicians is always using the same methods they know for every kind of data sets (5).

The biostatistician has become an integral member of the medical research team over the past decades and this trend will continue. Until recently, the biostatistician's role was to design the statistical aspects of the experiment or study, gather and organize the data, and analyze the results. This role has not changed. However, with the availability of powerful computer hardware and user-friendly computer software, which enables who are not statisticians to easily perform sophisticated statistical analyses (2). However, the benefits of easy access to the tools of statistical analysis can be overshadowed by the costs associated with misapplication of statistical methods (8). The analyzer who is not a statistician by entering the data in order to make a test which has some assumptions that the analyzer don’t know, in case of calculating a p value, can think that he/she made the analysis properly (5).

The regulatory authorities agree that statistics should form part of medical education (4). Good biostatistics education should be well-balanced in theory and application topics education, include real-life data for application, use statistics packages that are menu-driven and not use the methodological details (1, 3, 4, 11, 12). Instructors should be cautious about the period of biostatistics course and selection of the topics and those topics should include the details according to the structure of the society. Biostatistics education should be given so cautious about the items given above that, this education should provide additional benefit to analytically thinking on the subjects related with their career, and should provide understanding the statistical interpretation in the literature and provide additional ability for performing the statistical analysis for the researches they will execute.

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