An International Survey of Physicians' Knowledge of Biostatistics

Hekimlerin Biyoistatistik Bilgisini Belirlemeye Yönelik Uluslararası Anket Çalışması

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ABSTRACT Objective: The primary aim of our study, an international web-based survey, is to obtain (I-a) physicians' statistical knowledge and (I-b) how this varies by their focus area (basic, internal and surgical). The secondary aim is to address the following questions: (II-a) to specify when in the medical education biostatistics course should be taught and (II-b) to identify the key statistical methods relevant to medical education. **Material and Methods:** A total of 278 physicians from 59 countries, who were invited to participate in our survey by e-mail, participated in our study. Physicians' data were obtained via a web-based survey. **Results:** Most of the physicians stated that biostatistics course should be taken at the undergraduate and at the residency. When we investigated the physicians' knowledge of statistical topics there was no difference between resident, specialist and academic staff. Although there were no differences according to statutes in terms of statistical knowledge level, it was observed that the knowledge levels were so low in all statistical topics, except the parametric tests. Especially it was found that the knowledge level about the sampling techniques was at the lowest degree. **Conclusion:** When the studies were evaluated, it was seen that statistics is one of the most important factors in respect to the reliability of conducted studies. Therefore researchers should have the basic statistical knowledge and have basic knowledge level on the specific statistical methods which are used in their research areas; also should take consultation from the biostatistics specialist.

Anahtar Kelimeler: Biostatistics; education, medical, undergraduate; physicians

ÖZET Amaç: Uluslararası kapsamda web-tabanlı olarak yaptığımız anket çalışmasının ilk amacı (I-a) hekimlerin istatistiksel bilgi düzeyini ve (I-b) bu düzeyin çalıştıkları alanlara göre değişimini incelemektir. İkinci amaç ise izleyen iki soruya cevap aramaktır: (II-a) tıp eğitiminde biyoistatistik dersinin verilme zamanının belirlenmesi ve (II-b) tıp eğitimi ile ilgili anahtar istatistiksel metotların belirlenmesidir. **Gereç ve Yöntemler:** E-posta yoluyla davet edilen 59 ülkeden 278 hekim çalışmamıza katılmıştır. Hekimlerin verileri web-tabanlı anket ile elde edilmiştir. **Bulgular:** Hekimlerin büyük bir çoğunluğu biyoistatistik eğitiminin hem lisans döneminde hem de uzmanlık döneminde alınması gerektiğini belirtmektedirler. Hekimlerin istatistik konularını bilme düzeyleri incelediğinde uzmanlık yapanlar, uzman olanlar ve akademisyenler arasında bir farklılık bulunmamıştır. Statülere göre istatistik bilgi düzeyleri hakkında farklılık olmamasına rağmen, parametrik testler dışındaki istatistik konularına ait bilgi düzeyinin oldukça düşük olduğu görülmektedir. Özellikle örnekleme yöntemleri hakkındaki bilgi düzeyi diğer istatistik konularına göre en düşük düzeyde bulunmuştur. **Sonuç:** Çalışmalar değerlendirildiğinde, istatistiğin çalışmaların güvenilirliği bakımından en önemli faktörlerden biri olduğu görülmektedir. Bu sebeple araştırmacılar istatistiğe ve kendi alanlarında kullanılan özel istatistiksel yöntemlere ilişkin temel bilgilere sahip olmalı; ayrıca biyoistatistik uzmanından danışmanlık almalılardır.

Key Words: Biyoistatistik; eğitim, tıp, üniversite; doktorlar

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The studies concerning statistical errors in the medical studies are numerous. Some of these studies have found the errors by reviewing the studies after their submission or publication while some of them are educational studies which intended to prevent the statistical errors.[1-5] These studies emphasise the importance of statistical knowledge and education. Assessment of statistical knowledge of clinicians have shown little change during the past several decades and suggests little is known about how to accomplish such improvement. Understanding current perceptions held by physicians regarding statistics and its role both in research and clinical practice may be helpful in improving education on this subject.[6]

As the importance given to biostatistics education increases, it is important to know the opinions of physicians 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 it is also important for planning of curriculum for both undergraduate and graduate education.[7]

The most important factors which are effective for physicians' career development are following scientific documents regarding their profession and participating in scientific meetings. Therefore, even if physicians do not conduct a research by themselves, they should have statistical knowledge at a certain level.

The primary aim of our study, an international web-based survey, is to obtain (I-a) physicians' statistical knowledge and (I-b) how this varies by their focus area (basic, internal and surgical). The secondary aim is to address the following questions: (II-a) to specify when in the medical education biostatistics course should be taught and (II-b) to identify the key statistical methods relevant to medical education.

MATERIAL AND METHODS

In our study, physicians' data were obtained by a web-based survey, and the questions were constructed according to the aims of the study. The corresponding participants were confirmed as physicians by searching PubMed database by using the keywords "medicine school/faculty of medicine/school of medicine/medical faculty" for the years 2000–2012. The participants were selected by using a random number table and were invited to participate in the survey by an e-mail. The physicians who joined the study were directed to the survey web page, which was designed for this study. Responses of physicians were recorded in a database.

A total of 278 physicians from 5 continents and from 59 countries participated in our study. Of those, 20 were residents, 51 were specialists, 74 were assistant professors, 63 were associate professors and 70 were professors.

In the first part of the questionnaire, there were three questions. The subjects were asked if they thought a biostatistics course would be useful for their future careers (completely disagree: 0 – completely agree: 4), at which semester or semesters the biostatistics education should be administered, and how much importance they placed on biostatistics (not important: 0 – very important: 10).

In the subsequent part of the questionnaire, the physicians were asked which statistical methods, tests and techniques they knew out of 54 different methods and techniques. The physicians were not asked about their complete knowledge of the methods, tests and techniques, but only their general knowledge about them was assessed. In the questionnaire, methods, tests and techniques were grouped as "general statistics knowledge", the topics from undergraduate courses were defined as "the topics included by curriculum" and the subjects that were not taught in undergraduate courses were 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 physician was converted to a ratio by dividing the number of methods, tests and techniques that the participant knew by the total number of methods, tests and techniques in that subject group.

In this study, the Shapiro-Wilk normality test was applied to determine whether the variables were normally distributed. The variables did not

show a normal distribution. For comparison, the Kruskal-Wallis test, Mann-Whitney U test, Friedman test and Wilcoxon signed rank test were applied with a significance level of α=0.05. After post-hoc comparisons, a Bonferroni correction was applied, and the resulting significance level (α/k, k = number of pairwise comparisons) was taken into account. The median, minimum and maximum values of the previously described statistics knowledge ratio were reported for each subject group.

RESULTS

The demographic characteristics of the participants and their distribution by countries are given in Tables 1 and 2.

The distribution of participants by periods when they were administered the biostatistics course and the distribution of the preferred time for administering a biostatistics course for non-academic and academic staff responses are given in Table 3 and Table 4, respectively. All participants who did not administer a biostatistics course (19.42%, n=54) stated that biostatistics course should be administered. Of these 54 participants, 98.1% (n=53), stated that there is need to administer a biostatistics course.

Statistical software used by physicians for statistical analysis is given in Table 5.

The opinions of physicians according their status and their research area are given in Table 6 and Table 7, respectively.

The statistical knowledge levels of physicians are given in Tables 8, 9 and 10.

TABLE 1: Demographic characteristics of the participants.

Age (years)	44.95(10.57)
Female-Male	73(26.30)-205(73.70)
Years of work experience	22.41(10.94)
Status	
At the residency	20(7.20)
Specialist	51(18.30)
Assistant Professor	74(26.60)
Associate Professor	63(22.70)
Professor	70(25.20)

Values are represented as mean (standard deviation) and n (%).

The relationship between physicians' knowledge of statistical methods and the number of their published articles is given in Table 11.

The attitude of physicians' use of biostatistical consultation is given in Table 12.

DISCUSSION

For inference in a study regarding a specific topic, the decision making purified from subjective judgements is only possible with statistics. Hence, statistics is needed at every stage of the research beginning from planning to the end, in order to gain scientifical importance and to obtain reliable results.[1] The majority of journal articles are accompanied by statistics.[8]

The use of the inappropriate statistical method, technique and the analysis cause time and money loss, and most importantly thinking in the way of scientific ethics, it gives harm to science and humanity.[1] In order to prevent these undesired situations, it is highly important that researchers'

TABLE 2: Distribution of the participants according to continents and countries.

Continent n (%)	Country
Africa 28 (10.07)	Egypt (19), Nigeria (3), Ethiopia (2), Sudan (2), Gabon (1), Zimbabwe (1)
America 68 (24.46)	United States (53), Canada (6), Brazil (2), Chile (2), Mexico (2), Belize (1), Colombia (1), Uruguay (1)
Asia 99 (35.61)	Turkey (23), Iran (22), Israel (14), Thailand (12), Saudi Arabia (6), India (3), Pakistan (3), Sri Lanka (3), Iraq (2), Malaysia (2), Bahrain (1), Cambodia (1), China (1), Hong Kong (1), Kuwait (1), Lebanon (1), United Arab Emirates (1), Vietnam (1), Yemen (1)
Europe 80 (28.78)	Czech Republic (14), United Kingdom (10), Germany (6), Spain (6), Croatia (5), Serbia and Montenegro (5), France (4), Italy (3), Norway (3), Portugal (3), Slovakia (3), Bulgaria (2), Denmark (2), Greece (2), Malta (2), Belgium (1), Bosnia and Herzegovina (1), Georgia (1), Isle of Man (1), Macedonia (1), Poland (1), Romania (1), Slovenia (1), Sweden (1), Switzerland (1)
Oceania 3 (1.08)	Australia (3)

TABLE 3: Distribution of participants according to the time for enrolling in a biostatistics course.

	n (%)
At the first half of undergraduate education (2)	93(33.45)
I didn't get any biostatistics course (1)	54(19.42)
At the second half of undergraduate education (3)	35(12.59)
At the last years of residency (6)	21(7.55)
At the first years of residency (4)	19(6.83)
At the middle of residency (5)	13(4.68)
(2)-(4)	10(3.60)
(2)-(6)	8(2.88)
(2)-(3)	7(2.52)
(2)-(5)	7(2.52)
(3)-(4)	2(0.72)
(3)-(6)	2(0.72)
(3)-(5)	1(0.36)
(2)-(3-(6)	1(0.36)
(4)-(5)-(6)	1(0.36)
(2)-(3)-(4)-(5)	1(0.36)
(2)-(3)-(5)-(6)	1(0.36)
(2)-(4)-(5)-(6)	1(0.36)
(3)-(4)-(5)-(6)	1(0.36)
Total= 278	

have statistical knowledge at a certain level. Hence, at which period and which statistical subjects should be given to physicians in biostatistics courses is a research topic. Furthermore, statistical topics which should be given to researchers who study in the subdisciplines of medical science should be invesigated. In our study, 19.42% of the participants stated that they did not take a biostatistics course during their education. The physicians who did not take a biostatistics course remarked that a biostatistics course should be offered, which shows that they feel the insufficiency of not being offered such a course, because 98.1% of these physicians stated that a course should be taken. Most of participants (46%) stated that they took a biostatistics course at the postgraduate level. According to study of Hanif et al., 30.27% of post graduate medical students have not already taken a biostatistics course.[9] It seems logical that different medical schools utilize different curricula, on the basis of some participants noting that they did not take a biostatistics course during their education and by the fact that some participants received biostatistics instruction at different levels of education.

In our study, residents, specialists and academic staff have different opinions regarding the period in which biostatistics courses should be taken. Physicians' opinions about the period of taking the biostatistics course accumulates as three different manners. Some of them stated that biostatistics course should be taken at undergraduate; some of them stated that biostatistics course should be taken at undergraduate and residency, and the others stated that biostatistics course should be taken at only residency. Most of the physicians stated that biostatistics course should be taken at the undergraduate education and at the residency. It was found that, physicians gave more importance to the biostatistics course after the graduation.[7] The reason for this can be they realise the importance of biostatistics as soon as they start to part in clinical studies. Altman and Bland also stated that; undergraduate students' main objective is success in statistical courses, and students cannot gain a clear understanding of the importance of biostatistics but after graduation when they participate in research, even if only temporarily, there is considerable motivation to obtain a sufficient understanding of basic statistical methodology.[10] According to study of Hanif et al., 98.16% of

TABLE 4: The distribution of the preferred time for administering a biostatistics course according to non-academic and academic staff responses.

	Resident (n=20)		Specialist (n=51)		Academic staff (n=202)		Total (n=273)	
Class	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**
Undergraduate education	30.00	6	23.53	12	26.73	54	26.37	72
Undergraduate & residency	35.00	7	35.29	18	44.55	90	42.12	115
Residency	35.00	7	39.22	20	28.71	58	31.13	85
No need for a biostatistics course	0.00	0	1.96	1	0.00	0	0.38	1

TABLE 5: Statistical software used by physicians for statistical analysis

Software	n	%
SPSS	156	65.00
STATA	18	7.50
EPIINFO	14	5.83
EXCELL	10	4.17
SAS	9	3.75
GRAPHAD PRISM	5	2.08
STATISTICA	4	1.67
SIGMA STAT	3	1.25
SYSTAT	3	1.25
JMP	2	0.83
MEDCALC	2	0.83
R	2	0.83
INSTAT	1	0.42
KyPLOT	1	0.42
MATLAB	1	0.42
MINITAB	1	0.42
NCSS	1	0.42
PRIMER	1	0.42
STATGRAPHICS	1	0.42
STATS DIRECT	1	0.42
STATVIEW	1	0.42
WINDOWS CALC.	1	0.42
WINKS	1	0.42

postgraduate medical students stated that this course was useful for them.[9] For that reason, to show the importance of the biostatistics course, it will be useful to give article review and discussion courses, at the last stages of undergraduate education. As a result, there were suggestions for taking the biostatistics course in each education period.

When we investigated the participants' statistical software preferences, SPSS was found to be the most preferred statistical software (65%). As expected, most physicians in our study prefer user-friendly programs, though a small percentage of the physicians (5%) prefer to use software that is not user-friendly. Smeeton examined the statistical software used in 9 dental schools in England and Ireland, and found that in most dental schools, SPSS (5/9) and Minitab (3/9) packages were preferred.[11] Daher and Amin a performed study on 2nd year medical students and found that 19.6% of students had licensed SPSS software and 24.6% possessed free Epi Info software.[12]

According to our international study; residents, specialists and academic staff think that taking a biostatistics course is useful for a physician's profession and biostatistics is highly important in medical sciences. When we group physicians as being in basic, internal and surgical subdisciplines, they still think that biostatistics is highly important. A similar study in Turkey, conducted by Ercan et al. on physicians, showed that the physicians in the subdisciplines find a biostatistics course useful for their profession, but they do not find it as important as in the present study.[7] Differently, in the study of Ercan et al., opinions of physicians about the importance of biostatistics differ in different subdisciplines.[7] In that study, physicians in surgical disciplines give less importance to biostatistics compared to physicians in basic sciences and internal medicine disciplines. It is supposed that in Turkey, physicians generally give

TABLE 6: The descriptive values and comparisons of whether taking a biostatistics course is useful for one's occupation and the importance placed on biostatistics in medicine science according to non-academic and academic staff responses.

	Do you agree with the idea that taking a biostatistics course is beneficial for a physician's profession? (min-max:0-4)				What is the importance of biostatistics in medicine science? (min-max:0-10)			
Status	**n**	**Median**	**Min**	**Max**	**n**	**Median**	**Min**	**Max**
Resident	20	3.50	0.00	4.00	20	9.00	7.00	10.00
Specialist	51	4.00	1.00	4.00	51	9.00	5.00	10.00
Academic Staff	207	4.00	0.00	4.00	207	10.00	3.00	10.00
p value (α=0.05)			0.390				0.717	

Min: Minimum, Max: Maximum.

TABLE 7: The descriptive values and comparisons whether enrolling in a biostatistics course is useful for one's occupation and the importance placed on biostatistics in medicine science according to physician by research area.

	Do you agree with the idea that taking a biostatistics course is beneficial for a physician's profession? (min-max:0-4)				What is the importance of biostatistics in medicine science? (min-max:0-10)			
	n	Median	Min	Max	n	Median	Min	Max
Basic Medicine	57	4.00	0.00	4.00	57	10.00	5.00	10.00
Internal Medicine	156	4.00	0.00	4.00	156	9.00	5.00	10.00
Surgical Medicine	65	4.00	0.00	4.00	65	10.00	3.00	10.00
p value (α=0.05)	0.247				0.421			

TABLE 8: The descriptive values and comparisons of the level of statistics knowledge possessed by non-academic and academic staff responses.

		Biostatistics subjects							
Status		Sampling methods	Parametric tests	Non-parametric tests	Multivariate methods	Survival analysis methods	General statistics	Curriculum topics that are common	Curriculum topics that are not common
Resident	Median	0.00	57.14	28.57	8.33	33.33	21.30	34.00	14.81
n=20	Min	0.00	14.29	0.00	0.00	0.00	3.70	4.00	0.00
	Max	50.00	100.00	85.71	75.00	100.00	77.78	84.00	70.37
Specialist	Median	0.00	71.43	28.57	8.33	0.00	24.07	40.00	11.11
n=51	Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Max	100.00	100.00	85.71	75.00	100.00	81.48	92.00	70.37
Academic staff	Median	0.00	71.43	35.71	8.33	33.33	25.93	40.00	14.81
n=207	Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Max	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
p-value (α=0.05)		0.214	0.301	0.570	0.372	0.610	0.471	0.464	0.539

Min: Minimum, Max: Maximum.

TABLE 9: The descriptive values and comparisons of the level of statistics knowledge.

	Biostatistics subjects				
	Sampling methods	Parametric tests	Non-parametric tests	Multivariate methods	Survival analysis methods
Median	0.00	71.43	32.14	8.33	33.33
Min	0.00	0.00	0.00	0.00	0.00
Max	100.00	100.00	100.00	100.00	100.00
p-value (α=0.05)	<0.001				
	Pairwise comparisons (α*=0.005)				
Sampling methods (1)	1-2: **p<0.001**, 1-3: **p<0.001**, 1-4: **p=0.001**, 1-5: **p<0.001**				
Parametric tests (2)	2-3: **p<0.001**, 2-4 **p<0.001**, 2-5: **p<0.001**				
Non-parametric tests (3)	3-4: **p<0.001**, 3-5: **p=0.230**				
Multivariate method (4)	4-5: **p<0.001**				
Survival analysis methods (5)					

Min: Minimum, Max: Maximum.

importance to biostatistics, but it is still less than the present international study.[7] Miles et al. stated that, whilst less than half of doctors recognised the value of their own undergraduate training in prob-

TABLE 10: The descriptive values and comparisons of the level of statistics knowledge possessed by physicians according to research area.

		Biostatistics subjects							
		Sampling methods	Parametric tests	Non-parametric tests	Multivariat e methods	Survival analysis methods	General statistics	Curriculum topics that are common	Curriculum topics that are not common
Basic medicine	Median	0.00	71.43	28.57	8.33	0.00	24.07	36.00	11.11
n=57	Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Max	100.00	100.00	85.71	91.67	100.00	81.48	92.00	70.37
Internal medicine	Median	0.00	71.43	35.71	12.50	33.33	25.93	40.00	14.81
n=156	Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Max	100.00	100.00	85.71	83.33	100.00	85.19	96.00	74.07
Surgical medicine	Median	0.00	71.43	28.57	8.33	33.33	25.93	36.00	14.82
n=65	Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Max	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
p-value (α=0.05)	0.802	0.228	0.702	0.600	**0.020**	0.883	0.824	0.607	
Basic M.- Internal M. (α*=0.017)					**0.009**				
Basic M.- Surgical M. (α*=0.017)					**0.014**				
Internal M.- Surgical M. (α*=0.017)					0.762				

Min: Minimum, Max: Maximum.

TABLE 11: The relationship between physicians' knowledge of statistical methods and the number of their published articles.

		Biostatistics subjects							
Number of published articles		Sampling methods	Parametric tests	Non-parametric tests	Multivariate methods	Survival analysis methods	General Statistics	Curriculum topics that are common	Curriculum topics that are not common
Articles in indexed journals	r	-	0.184	0.207	0.294	0.180	0.227	0.161	0.258
(SCI, SCI EXP, SSCI)	p-value	0.897	**0.002**	**0.001**	**<0.001**	**0.003**	**<0.001**	**0.007**	**<0.001**
Articles (list as the first author)	r	-	0.170	0.205	0.310	0.193	0.229	0.156	0.271
in indexed(SCI, SCI EXP, SSCI) journals	p-value	0.978	**0.005**	**0.001**	**<0.001**	**0.001**	**<0.001**	**0.010**	**<0.001**
Articles in journals that are not indexed	r	-	-	-	-	-	-	-	-
	p-value	0.633	0.744	0.054	0.083	0.068	0.152	0.445	0.053
Articles (list as the first author) in	r	-	-	-	0.131	-	-	-	0.142
journals that are not indexed	p-value	0.695	0.741	0.093	**0.030**	0.059	0.118	0.523	**0.018**
Number of total published articles	r	-	0.131	0.198	0.267	0.187	0.202	0.127	0.248
	p-value	0.704	**0.031**	**0.001**	**<0.001**	**0.002**	**0.001**	**0.036**	**<0.001**
Number of total published articles	r	-	0.123	0.188	0.275	0.189	0.201	0.123	0.255
(list as the first author)	p-value	0.806	**0.043**	**0.002**	**<0.001**	**0.002**	**0.001**	**0.043**	**<0.001**

TABLE 12: The frequency of physicians' use of biostatistical consultation.

Consultation Stage		**% (n)**
(1) I get consultation at the stage of designing the study	(1)-(2)-(3)	6.47 (18)
(2) I get consultation during the research	(1)-(2)-(3)-(4)	2.88 (8)
(3) I get consultation during the statistical analysis and interpretation	(1)-(2)-(3)-(4)-(5)	8.27 (23)
(4) I get consultation after writing and while proofreading the manuscript	(5)	1.80 (5)
(5) I get consultation if the manuscript that I submitted to a journal isn't accepted because of statistical analysis	(6)	11.87 (33)
(6) I never get consultation		**n= 278**

ability and statistics at the time (40%), the majority (73%) had found their learning relevant to their subsequent career.[13] An improved understanding of biostatistics is necessary for clinicians. This need is clearly recognized by physicians, and even experienced researchers with statistical training report discomfort with biostatistical concepts.[6]

According to present study focusing on medical physicians' knowledge of statistics, there is no significant difference in the knowledge among the ones in basic science, internal science or surgical science with regard to sampling methods, parametric and nonparametric tests, general statistics, multivariate methods, curriculum topics that are common and not common; however, there is a significant difference in their knowledge of survival analysis methods. As expected, physicians in the internal and surgical sciences have greater knowledge about the survival analysis compared to the physicians in the basic sciences. The study of Ercan et al. showed that the physicians in the basic sciences had more knowledge about the parametric tests and in the common curriculum topics compared to the physicians in the internal sciences.[7] This finding is compatible with our study where physicians in the internal sciences had more knowledge about the survival analysis compared to the physicians in the basic sciences. In similar studies, it was seen that the survival analysis was one of the least known statistical topics.[9,14,15] The reason of lack of knowledge on the survival analysis may be its use only in in some sub-disciplines. While the basic biostatistical methods should be taught in the undergraduate education program, the education programs after graduation must take statistical methods which are condensed into consideration by considering the research areas that should be in the content of curriculum.

When we investigated the physicians' knowledge of statistical topics, we did not find any differences between residents, specialists and the academic staff. Although there were no differences according to statutes in terms of statistical knowledge level, it was observed that the knowledge levels were so low in all statistical topics, except the parametric tests. Importantly, it was found that the knowledge level about the sampling techniques was at the lowest degree. The finding that physicians are almost completely unaware of sampling techniques is somewhat unsettling because sampling is the first important topic that a researcher considers during the planning stage of the study. Researchers hope that the data collected from given samples and its interpretation will accurately reflect the conditions found in the general population or group.[8] For this reason, to make a consistent, efficient and unbiased prediction at the end of a study, it is important to apply sampling techniques accurately. Ercan et al. and Hanif et al. also stated that, the knowledge level about the sampling techniques was so low.[7,9] Ercan et al. interpreted their findings to mean that academic staff members need to learn statistical test methods to obtain results, but there is no obligation to learn sampling techniques.[7] Hence, they do not have enough motivation to learn these methods.[7] Removing bias and confounding variables from sample populations are continual challenges in research design. The subject of sampling, as it relates to the overall statistical effort, could (and does) fill chapters in biostatistics texts.[8]

In present study it was observed that one of the statistical topics in which the physicians' awareness was lowest was the multivariate statistical methods. Ercan et al. also obtained similar results for Turkish physicians.[7] They interpreted these results to mean that these methods require advanced mathematical basis and proficiency. Physicians in the health sciences may believe that their statistics knowledge is sufficient, and subsequently they do not consult a statistician. Thus, they may use univariate techniques instead of appropriate multivariate techniques.[7] Therefore, Ercan et al. believe that it is essential to teach general information about the aims and the use of multivariate statistical methods.[7]

According to results of our study, parametric tests were the most well-known statistical topics by the physicians. Physicians' awareness of parametric tests was found to be higher than awareness of nonparametric tests, yet nonparametric tests must be used when the assumptions for paramet-

ric tests are not satisfied. Before 1990, in most international papers (64.3%), only one type of statistical procedure was used. Among these papers, 78.4% used parametric tests, 16.5% used non-parametric tests, and 5.2% used both types of tests. An increase in the use of both types of tests concomitantly was noted during the last decade.[16] Usage of parametric tests in such an intensive manner and at the same time usage of non-parametric tests rarely, bring to mind the idea of researchers may perform parametric tests without investigating whether they provide the related assumptions casually. Therefore researches should be guided for this topic and according to the result of these researches, if it is really needed, more importance should be given to parametric and nonparametric distinction in the courses.

When we investigated the relationship between physicians' knowledge of statistical methods and the number of articles they published, there were significant relationships between the statistical topics except sampling methods and the number of published articles. This result shows that, with the increase in the number of published articles of the researchers, the knowledge level of the researchers also increases. However it is challenging that, lack of a relationship between the knowledge level of statistical methods and the number of published articles.

When the attitudes of physicians for using a biostatistical consultation was investigated, there was no difference between academic and non-academic physicians. In our study, it was found that the rate of physicians using biostatistical consultation during their research process was critically low. Obtaining the services of a statistician in the planning stage of your study is strongly encouraged to assist in the stages of "proper study design" and "conducting the study" in the research process before finally setting up the database and statistical analysis.[17] Hanif et al. also stated that every medical institute must have the biostatistician.[9]

When the studies were evaluated, it was seen that statistics is one of the most important factors for the reliability of the conducted studies. Therefore, researchers should have the basic statistical knowledge and have basic knowledge level on the specific statistical methods which are used in their research areas; also they should take consultation from the biostatistics specialist.

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