Standardization of the Content of Undergraduate Biostatistics Education in Medical Faculties – Two Panel Delphi Study

Tıp Fakültelerinde Lisans Biyoistatistik Eğitimi İçeriğinin Standardizasyonu – İki Panelli Delphi Çalışması

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Abstract

Aim: The first thing that comes to mind when considering standardization in education is curricula development. All graduates will have similar basic clinical skills if medical schools have standardized curricula. In this context, Delphi methodology is a useful way to set standards for biostatistics education in medical schools. Biostatistics education in medical schools should enable students to think analytically about their medical education. This course should be presented to students with different content for each education year. In this regard, universities providing biostatistics education with similar contents will enable students who graduated from medical school to have similar ability to think analytically and do research. This paper focused on expert feedback on course names, course contents, teaching methods, study plans, course duration, and grade level of the courses to standardize the content of undergraduate biostatistics education in medical faculties.

Methods: A Delphi technique was used. The study group consisted of biostatistics faculty members from various universities. A total of 23 experts participated in the first panel, and 16 experts participated in the second panel. Experts from different academic titles contributed to the discussions. All interviews were conducted online, and through structured Delphi rounds, the views of all participants were incorporated into the final consensus. Conducted through two online panels utilizing the Delphi method across three rounds, the study sought expert feedback on various aspects, including course names, contents, teaching methods, study plans, course duration, and grade levels. In the initial panel, issues lacking consensus

Anahtar Sözcükler: Biyoistatistik Müfredatı, Tıp Eğitimi, Delphi Yöntemi

Keywords: *Biostatistics Curriculum, Medical Education, Delphi Method*

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were deliberated in subsequent rounds with the second panel, leading to conclusive outcomes. The questionnaire for the online panels was meticulously crafted by aligning with the titles and contents of courses offered by medical faculties.

Results: After three rounds, the second panel reached a consensus on 25-course titles. There was a consensus on study plans and grade levels for all courses except for two study plans and one course grade level. Theoretical and applied course durations were defined. It has been determined that Biostatistics course titles should be distributed to 1-3 and 5th grades in the medical faculty from basic to advanced topics.
Conclusions: Biostatistics education should be given as introductory subjects in the first year of medical school, basic statistics in the third year, and advanced statistics in the fifth year. Focusing on the content of the Biostatistics course offered, this study provides a comprehensive framework for the biostatistics curriculum. We believe this content will contribute to developing the core curriculum in biostatistics.

Özet

Amaç: *Eğitimde standardizasyon düşünüldüğünde akla ilk gelen şey müfredat gelişimidir. Tıp fakültelerinde standardize edilmiş müfredatlar olduğunda mezunlar temel klinik becerilere sahip olacaklardır. Bu bağlamda, Delphi metodolojisi tıp fakültelerinde biyoistatistik eğitimi için standartlar belirlemek için kullanışlı bir yöntemdir. Biyoistatistik eğitimi, tıp eğitimi alan öğrencilerin analitik düşünmelerini sağlamalıdır. Bu ders, öğrencilere eğitim yılına göre farklı içeriklerle sunulmalıdır. Bu bağlamda, benzer içerikler sunan üniversiteler, tıp fakültesinden mezun olan öğrencilerin benzer şekilde analitik düşünme ve araştırma yapma yeteneğine sahip olmalarını sağlayacaktır. Bu makale, tıp fakültelerinde lisans biyoistatistik eğitiminin içeriğini standartlaştırmak için kurs adları, kurs içerikleri, öğretim yöntemleri, ders planları, ders süreleri ve ders sınıf seviyesi üzerine uzman görüşlerine odaklanmıştır.*

Yöntem: *Delphi tekniği kullanılmıştır. Çalışma grubu, çeşitli üniversitelerden biyostatistik anabilim dalı öğretim üyelerinden oluşmuştur. İlk panele toplamda 23 uzman, İkinci panele ise 16 uzman katılmıştır. Farklı akademik unvanlardaki uzmanlar tartışmalara katkıda bulunmuştur. Tüm görüşmeler çevrim içi olarak gerçekleştirilmiş ve yapılandırılmış Delphi turları aracılığıyla tüm katılımcıların görüşleri nihai uzlaşıya dahil edilmiştir. Üç raunt boyunca iki çevrim içi panel kullanılarak gerçekleştirilen bu çalışmada, ders başlıkları, içerikleri, öğretim yöntemleri, ders planları, ders süreleri ve sınıf seviyeleri gibi çeşitli yönlerde uzman geri bildirimleri alınmıştır. İlk panelde uzlaşı sağlanamayan konular ikinci panelde tartışılmış ve kesin sonuçlara ulaşılmıştır. Çevrim içi paneller için hazırlanan anket soruları, tıp fakültelerinin sunduğu ders başlıkları ve içerikleriyle uyumlu bir şekilde titizlikle hazırlanmıştır.*

Bulgular: *İkinci panel, üç raunt sonunda 25 ders başlığında uzlaşmaya varmıştır. Tüm dersler için ders planları ve sınıf seviyelerinde, iki ders planı ve bir ders sınıf seviyesi dışında, uzlaşı sağlanmıştır. Teorik ve uygulamalı ders süreleri belirlenmiştir. Biyoistatistik ders başlıklarının temelden ileriye doğru tıp fakültesinde 1-3 ve 5. sınıflara dağıtılması kararlaştırılmıştır.*

Sonuç: *Biyoistatistik eğitimi, tıp fakültesinin ilk yılında tanıtıcı dersler olarak, üçüncü yılda temel istatistikler olarak ve beşinci yılda ileri istatistikler olarak verilmelidir. Sunulan biyoistatistik kurs içeriğine odaklanan bu çalışma, biyoistatistik müfredatı için*

kapsamlı bir çerçeve sunmaktadır. Bu içeriğin biyoistatistik alanındaki çekirdek müfredatın geliştirilmesine katkı sağlayacağına inanıyoruz.

INTRODUCTION

Since the 1980s, the number of medical faculties has increased. These faculties have different facilities and infrastructures and implement different educational models and programs. However, whatever system or program they implement, they need a framework program to transform students into physicians with basic knowledge and skills. To this end, the Council of Higher Education (CoHE) worked with medical schools in the early 2000s to develop a National Core Education Program (1). Under the umbrella of the NCEP, medical schools have focused in recent years on developing core curricula to ensure that students do not experience information overload as the medical and health literature continues to expand. In addition, experts have frequently updated the medical education curriculum to ensure first national and then international standardization through specialization in areas of expertise. The content of the core curriculum is becoming increasingly important, as it significantly impacts determining the path that medical students will take during their specialty training. In 2020, experts last revised the National Core Curriculum for Undergraduate Medical Education and added 35 items under basic medical practices. Among these items, eight (23%) are directly related to the learning outcomes of the biostatistics course offered by medical schools. Biostatistics education based on this framework aims to transform students into physicians who take scientific thinking as the paradigm of rationality, make the right decisions based on positive scientific methods, define the environment and society correctly, and collect valid, reliable, and sufficient information to make the right decisions.

About 20 years ago, medical faculties used to construct biostatistics courses based on theoretical statistical knowledge. At that time, medical students performed basic statistical analyses manually because there were no computers or laboratories. Therefore, they could not put theoretical statistical knowledge into practice on real data sets. If students do not put theoretical statistical knowledge into practice, they will forget it. Therefore, we should question the effectiveness of undergraduate biostatistics education. Most departments use technology to convert theoretical statistical information into packaged programs. However, some departments still use outdated teaching methods. Each department has different biostatistics course contents. Therefore, we need to standardize the course names, course contents, teaching methods, study plans, course duration, and grade level of biostatistics education in medical schools. Standardization does not mean restricting the individual or the institution to specific patterns. Standardization in education aims to achieve goals and ensure continuous improvement and innovation. Accreditation, which is not independent of standardization, is the universal recognition of institutions.

The first thing that comes to mind when considering standardization in education is curricula development. All graduates will have similar basic clinical skills if medical schools have standardized curricula. In this context, we wanted to set standards for biostatistics education in medical schools. This paper focused on expert feedback on course names, course contents, teaching methods, study plans, course duration, and grade level of courses to standardize the content of undergraduate biostatistics education in medical faculties.

METHODS

We held two panels. Each panel had three stages based on the Delphi method, which is used to help people or groups with different perspectives reconcile without confrontation (Figure 1). In other words, the Delphi method is used to arrive at a group opinion or decision by interviewing a panel of experts. The Delphi method can be used to obtain valid and reliable results when decisions are likely to be influenced by powerful individuals or groups (2). The main features of the Delphi method are as follows: First, it guarantees confidentiality and anonymity. Second, it involves structured or semi-structured questionnaires. Third, it assists in the qualitative and quantitative analysis of group responses. Fourth, it allows participants to receive feedback on the results. Fifth, it encourages participants to reframe their thinking and make decisions at each stage. Sixth, it involves successive applications until consensus is reached (3, 4).

The Delphi method consists of stages that help experts elicit approaches and perspectives on a problem and reach a consensus. The stages and content of this study are as follows:

i- Recruitment

The Delphi sample should be at a level that reflects the expert opinion of the participants. Therefore, the study population consisted of all biostatistics academics (lecturers and graduate students) from medical faculties. The Biostatistics Association provided the email addresses of 153 academics. All academics were invited to participate in the study by email. The academics who met the inclusion criteria clicked on the link and completed the registration form.

ii- Drafting Questionnaires

We examined some undergraduate programs of departments teaching biostatistics in medical schools for more than 20 years and developed course content for 24 course titles. Since these undergraduate programs have been providing biostatistics education for years, the study was designed under the assumption that the faculties included in the study have similar attainment goals for biostatistics education. In addition to the course content, we also included open-ended questions about the lecture method [theoretical or applied (using a statistical package program), application (manual calculation or on Excel), practice [using a programming language], flipped class, homework, other], study plan (essential or optional), theoretical and applied course duration, grade level (1st, 2nd, 3rd, 4th, 5th, or sixth). The study was conducted under the hypothesis that if participants reached 70% consensus on a survey question in a round, consensus on that question was considered to have been reached. The consensus rate was calculated as the percentage of respondents who answered 1-2-3 or 7-8-9 for questions with response categories on a 1-9 Likert scale. For questions where more than one option could be selected, a consensus was determined by the most frequently selected answer.

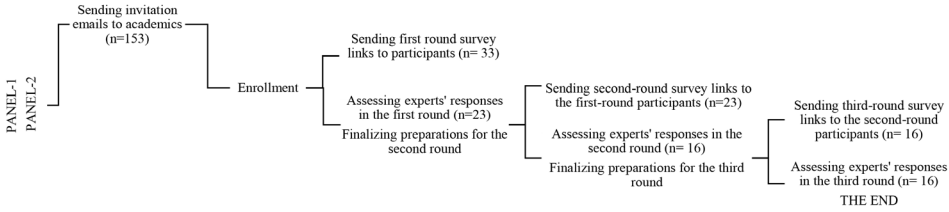

Figure 1. Flowchart of the Delphi study

iii- Administering the Questionnaires

The questionnaires were administered online to the experts consecutively in each round. Data were collected and managed using REDCap electronic data collection tools hosted at xxxx University Statistical Statistics Consultancy Application and Research Center (5, 6). REDCap (Research Electronic Data Capture) is a secure, web-based software platform designed to support data collection for research studies by providing 1) an intuitive interface for validated data collection, 2) audit trails for tracking data manipulation and export procedures, 3) automated export procedures for seamless data download to popular statistical packages; and 4) procedures for data integration and interoperability with external sources.

We held two panels. In the first panel, we sent invitation emails to 153 instructors registered with the Biostatistics Association to participate in the study. We sent the first-round questionnaire to 33 individuals who agreed to participate and met the inclusion criteria. The first-round questionnaire covered 24 course titles, 229 course contents, and 504 course syllabi (type of course, method of instruction, method of application, length of course, grade level, title, content, and general recommendations). Twenty-three participants completed the first round of the survey. They could not agree on 19 course titles, 92 course contents, and 83 syllabi. We asked them again in the second round. Sixteen participants responded. They could not agree on 16 course titles, 55 course contents, and 28 syllabi in the second round. So, we asked them again in the third round. Sixteen participants responded.

The results of the first panel were presented at the 21st National Biostatistics Congress. Based on the feedback, we revised the questionnaire to design the second online panel, considering the issues on which there was no consensus in the first panel. For the second panel, we sent invitation emails to 153 instructors registered with the Biostatistics Association. The sample for the second panel consisted of 24 participants. The first-round questionnaire was structured, covering 80 course contents and 182 syllabi. Eighteen participants completed the first round. They could not agree on 53 course contents and 31 syllabi in the first round. Therefore, we asked them again in the second round. Fourteen participants responded. They could not reach a consensus on 23 course contents and eight syllabi. Therefore, we asked them again in the third round. Thirteen participants completed the third round.

iv- Assessing Students' Ideas

We believed that addressing students' views of the course titles might also contribute to the results. The sample consisted of 13 students participating in the Biostatistics Literacy webinar series for two hours weekly for seven weeks in the 2020-2021 academic year. The webinar aimed to enable them to attain learning outcomes in addition to the knowledge they acquired in the first semester and to raise their awareness of the importance of biostatistics. Participants were asked whether the courses in the curriculum were necessary. The students whose opinions were questioned are studying at different grades at the undergraduate level in the faculty of medicine.

RESULTS

The first panel considered 24 course titles and 733 course content items. In the first round of the first panel, the participants agreed that the one-sample test course should be in the curriculum. In the same round, they recommended that the one-sample testing course be offered under the

Table 1. Final results on course titles (The table was created by taking into account the lecturing order of the course titles)

Course title	Year	Decision on the study plan	Lecture method	Weekly Class Hours	Applied
Introduction to biostatistics	1	Essential	Theoretical	4,5	-
Descriptive statistics	1	Essential	Theoretical + Applied	T 2 - A 1.5	Statistical package program
Research methods	1	Essential	Theoretical	4	-
Normal distribution and its properties	1	Essential	Theoretical	2	-
Summarizing data with appropriate descriptive statistics, tables, and graphs	1	Essential	Theoretical - Applied	T 2 – A 2	Statistical package program
Hypothesis testing-1	1	Essential	Theoretical	T 2	-
Sampling	1	Essential	Theoretical	T 2	-
Hypothesis testing-2	3	Essential	Theoretical - Applied	T 2 – A 1	Statistical package program
Hypothesis testing for two independent samples	3	Essential	Theoretical - Applied	T 2 – A 1	Statistical package program
Hypothesis testing for more than two independent samples	3	Essential	Theoretical - Applied	T 2 - A 2	Statistical package program
Hypothesis testing for two dependent samples	3	Essential	Theoretical - Applied	T 2 - A 1	Statistical package program
Hypothesis testing for more than two dependent samples	3	Essential	Theoretical - Applied	T 1.5 - A 1	Statistical package program
Chi-square tests of independence	3	Essential	Theoretical - Applied	T 2 - A 2	Statistical package program
Correlation analysis	3	Essential	Theoretical - Applied	T 2 - A 1.5	Statistical package program
Simple linear regression analysis	3	Essential	Theoretical - Applied	T 2 - A 1.5	Statistical package program
Sample size calculation	5	Essential	Theoretical - Applied	T 2 - A 2	Statistical package program
Survival analysis	5	Essential	Theoretical - Applied	T 2 - A 2	Statistical package program
Statistical methods for evaluating diagnostic tests	5	Optional	Theoretical - Applied	T 2 - A 2	Statistical package program
Univariate binary logistic regression analysis	5	Optional	Theoretical - Applied	T 2 - A 2	Statistical package program
Clinical trials	5	Essential	Theoretical	T 3	-
Multiple linear regression analysis	5	Optional	Theoretical - Applied	T 3 - A 2	Statistical package program
Statistical methods on healthcare management	5	Optional	Theoretical	T 4	Homework
Multiple binary logistic regression analysis	Should not be in the syllabus				

course title Hypothesis Testing-2. In the second round of the first panel, we asked the participants whether the Hypothesis Tests-2 course should also cover one-sample tests. More than half of the participants agreed (62.5%). We asked the same question in the third round of the first panel because we did not get a 70% consensus in the previous round. Seven out of ten participants noted that the Hypothesis Testing-2 course should also cover one-sample tests (70%).

As a result, the one-sample testing course was included in the Hypothesis Tests-2 course. In the second round of the first panel, participants agreed that the introduction to the Biostatistics course should cover basic definitions and types of variables related to data (73%). In the second round of the first panel, participants agreed that the course title Theoretical Distributions should be changed to Normal Distribution and Its Properties (70%). Finally, sixteen course titles were identified as required titles (Table 1). Participants agreed that fifteen required courses should be offered in the first and third semesters. They also agreed that seven of the fifteen required courses should be offered in the first semester (47%). Five of the seven required titles are theoretical titles, while the two are theoretical+applied titles. The total theoretical course duration is 18.5 hours, while the applied course duration is 3.5 hours. The participants concluded that eight of the fifteen course titles should be presented in the third semester. All these course titles are theoretical+applied titles. The total theoretical course duration is 15.5 hours, while the applied course duration is 11 hours. Most medical schools offer biostatistics as an elective clerkship course in the fifth semester. The participants noted that the course titles Sample Size Calculation and Survival Analysis should definitely be offered as two hours of theoretical and two hours of applied course at this level. In addition, participants concluded that the Clinical Trials course title should be offered as a three-hour theoretical course. The participants agreed that four courses with these titles should be taught in the fifth semester. Of these four courses, one is a theoretical course title, while the other three are theoretical+applied course titles. Participants indicated that a statistical package program must be used in all applied course titles (Table 1).

In the first round of the first panel, participants agreed that multiple binary logistic regression analysis should not be included in the curriculum (85%). Therefore, multiple binary logistic regression analysis was removed from the curriculum. The Statistical methods on healthcare management course, which was not addressed in the first panel but was added to the second panel as a result of feedback from the congress, was addressed in the second panel and added to the curriculum. In addition, it was deemed appropriate to add an article evaluation to each course content, as suggested by the congress, and this content was addressed in the second panel. Table 2 shows the final results for the course content that was agreed not to be included in the course title. Table 3 shows the final results for the course content that was not agreed to be included/not included in the course title content. See the online appendix for detailed information.

The results indicate that biostatistics education is necessary for 22 course titles in medical school's first, third, and fifth years. Students were also asked whether these 22 course titles should be included in the medical school curriculum, and at which grade level they should be offered. Most students (85%) were third-year students who requested additional courses to increase their knowledge of biostatistics. All students stated that the 22 course titles should be included in the curriculum. They noted that these course titles should be covered in the first and third years.

Table 2. Course contents not included in the course title content.

Course Title	Course contents not included in the course title content
Introduction to biostatistics	Non-probability sampling methods
Descriptive statistics	Harmonic mean
Research methods	Qualitative research
Normal distribution and its properties	Exponential distribution
Summarizing data with appropriate descriptive statistics, tables, and graphs	Stem-and-leaf plot
	Population pyramid
	Forest plot
	Funnel plot
Sampling	Purposive sampling method
	Monograph
	Capture-recapture sampling method
Hypothesis testing for more than two independent samples	Fisher's LSD test for multiple comparisons in ANOVA
	Sidak test for multiple comparisons in ANOVA
	Tukey's-b test for multiple comparisons in ANOVA
	Dunnet test for multiple comparisons in ANOVA
	Duncan test for multiple comparisons in ANOVA
Chi-square tests of independence	Likelihood ratio test
Correlation analysis	Polyserial correlation coefficient
	Polychoric correlation coefficient
	Double series correlation coefficient
	Point pairwise correlation coefficient
Sample size calculation	Sample size and power calculation for nonparametric tests for two independent samples
	Sample size and power calculation for nonparametric tests for more than two independent samples
	Sample size and power calculation for nonparametric dependent sample tests
	Sample size and power calculation for simple linear regression analysis
Survival analysis	Comparison of survival curves with the Gehan method
	Comparison of survival curves with the Tarone and Ware method
	Comparison of survival curves with the Prentice method
Clinical trials	Sequential trials
	Sample size calculations for parallel experimental designs
	Sample size calculations for cross-over trial designs
	Sample size calculations for multifactorial trials
	Sample size calculations for multicenter trials
	Sample size calculations for consecutive trials

Table 3. Final results regarding the course contents that cannot be agreed to be included/not included in the course title content.

Course title	Course contents for which there is no consensus
Descriptive statistics	Geometric mean
	Quartile deviation
Research methods	Consistency studies
	Systematic review
Normal distribution and its properties	Poisson distribution
Summarizing data with appropriate descriptive statistics, tables, and graphs	Nested tables
	Frequency polygon
Sampling	Quota sampling
	Field sampling
	Snowball sampling
	Multistage sampling method
Sample size calculation	Sample size and power calculation for parametric dependent sample tests
	Sample size and power calculation for correlation analysis
Statistical methods on healthcare management	Statistical methods on migration
	Statistical methods for marriage and divorce
	Statistical methods on miscarriages
	Statistical methods on family planning services
	Statistical methods on health, workforce, and occupational health
	Statistical methods on death report writing rules

DISCUSSION

This study aimed to standardize the content of biostatistics education. To this end, we focused on expert opinions regarding course titles, course content, teaching methods, the decision to lecture, the course title, course duration, and the grade level at which the course should be offered. A total of six rounds of consensus sessions were organized in two panels with biostatistics experts. The sample of the first panel consisted of sixteen biostatistics experts: four professors, three associate professors, five assistant professors, and four research assistants. The sample of the second panel consisted of 13

experts: two professors, two associate professors, four assistant professors, and five research assistants. A similar number of participants from each title increased the study's validity. An essential aspect of the Delphi method is ensuring that all participants can express their views. All of our participants had a Ph.D. in biostatistics, which increased the reliability of the results. The Delphi method requires 9-1000 participants. Therefore, we believe that our results will contribute to the literature. This is the first study on the standardization of biostatistics training in medical schools. We believe that our results will help experts to develop biostatistics curricula.

It was concluded that 52 hours of theoretical and 24.5 hours of applied biostatistics education are required in 22 course titles in the first, third, and fifth years of medical school. Özdamar stated that the ideal biostatistics education requires 155 hours for subjects that can be grouped into 14 clusters. However, many medical schools offer very few hours of biostatistics courses, which is a significant limitation in achieving the goals. Özdamar recommended that these 14 clusters be distributed across the first, third, fourth, and fifth years. Our participants distributed the course titles across the first, third, and fifth years. However, most medical faculties in the world offer the biostatistics course in the first year. However, first-year students do not understand the necessity and importance of the biostatistics course because they have not done research or clinical rotations. Therefore, they cannot associate the concepts and methods of biostatistics with medicine. The distribution of course titles suggested by our participants is compatible with the students' medical knowledge. Sami 2010 argues that formulas, manual calculations, and formal presentations make biostatistics courses boring (7). Our participants agreed that all applied course titles should include a statistical package program. Colton 1975 states that students think biostatistics education's primary purpose is to ensure critical reading of medical literature (9). Ercan et. al. 2008 claim that students quickly forget what they learn in biostatistics courses because they do not follow the literature during their medical education (9). Our participants agreed on the need to provide students with article reviews related to course content in all course titles. It is an excellent achievement for medical students to be familiar with biostatistical terminology and to be able to scientifically evaluate current studies from their first year.

Our study has some limitations. The fact that only faculty members from the Department of Biostatistics participated in the evaluation through the Delphi method may have limited the generalizability of the results to medical education as a whole. In future studies, the participation of a broader and more diverse group of stakeholders could help the curriculum better address the needs of medical faculties. Additionally, a more in-depth analysis of the course titles created in terms of the overall flow and integration of the curriculum could contribute to presenting topics in a more sequential and consistent manner.

CONCLUSIONS

Biostatistics education in medical schools should enable students to think analytically about their careers and to understand statistical interpretations in articles. In this context, undergraduate biostatistics education must be satisfactory. Some argue that standardization of curricula creates uniformity and hinders the development of science. However, standardization is an essential prerequisite for high quality. The benefits of standardization and accreditation are now widely accepted.

Our participants reached a consensus on the most critical topics in biostatistics education, which improved the quality of the content of biostatistics education. We believe our results will guide departments considering revising their programs or those considering establishing new departments. Studies should be conducted to determine whether a biostatistics education program based on the content obtained from this study is more effective than the current one. This study will lead to other studies to be planned for this purpose.

Ethical Considerations: The study was approved by the Social and Human Sciences Ethics Committee of Ankara Yildirim Beyazit University (No:31.07.2019-19). The results of the first panel of the study were presented at the 21st National Biostatistics Congress held in Türkiye.

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