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Results of Applied Biostatistics Course for Medical Specialty Students: Effect on Statistics Anxiety

Tıpta Uzmanlık Öğrencileri İçin Uygulamalı Biyoistatistik Kursunun Sonuçları: İstatistik Kaygısı Üzerine Etkisi

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Öz

İstatistik kaygısı, özellikle kanıta dayalı karar vermenin kritik olduğu sağlık bilimleri alanında, akademik ve profesyonel gelişim açısından önemli bir engeldir. Bu çalışma, "Uygulamalı Temel Düzey Biyoistatistik Kursu"nun tıpta uzmanlık öğrencilerinde istatistik kaygısını azaltmadaki etkisini araştırmaktadır. Çalışmaya, Muğla Sıtkı Koçman Üniversitesi Tıp Fakültesi'nde üç günlük kursa katılan 16 tıpta uzmanlık öğrencisi dahil edilmiştir. Kurs öncesi ve sonrası veriler, endişe, kaçınma ve duygusallık boyutlarını içeren 17 maddelik İstatistik Kaygısı Ölçeği kullanılarak toplanmış ve analiz edilmiştir. Normallik varsayımlarına bağlı olarak parametrik ya da parametrik olmayan testler uygulanmış, iç tutarlılık Cronbach'ın alfa katsayısı ile değerlendirilmiştir. Sonuçlar, kurs sonrası istatistik kaygı düzeylerinde anlamlı bir düşüş olduğunu göstermiştir ($p<0.001$). İstatistik Kaygısı Ölçeği'nin tüm boyutlarında (endişe, kaçınma ve duygusallık) puanların azaldığı belirlenmiş ve uygulamalı eğitimin etkinliği kanıtlanmıştır. İç tutarlılığın tüm boyutlarda artması, katılımcıların kavrayış ve güven düzeylerinin yükseldiğini göstermektedir. Bu çalışma, Muğla Sıtkı Koçman Üniversitesi'nde sunulan uygulamalı Biyoistatistik kursunun istatistik kaygısını azaltmadaki etkisini vurgulamaktadır. Teorik istatistik ile bilgisayar uygulamalarının entegrasyonu, çalışma grubunun istatistiksel gereklilikleri karşılamaya yönelik bilişsel ve duygusal hazırlığını artırmıştır.

Anahtar Kelimeler: Biyoistatistik, İstatistik Kaygısı, Uygulamalı Biyoistatistik, Biyoistatistik Kursu

Abstract

Statistics anxiety is a significant academic and professional development barrier, particularly in health sciences, where statistical competency is critical for evidence-based decision-making. This study examines the effects of the "Applied Basic Level Biostatistics Course" on reducing statistics anxiety among postgraduate medical specialty students. The study included 16 medical specialty students at Muğla Sıtkı Koçman University Faculty of Medicine who participated in a three-day course. Pre- and post-course data were collected and analysed using the Statistical Anxiety Scale with 17 items across worry, avoidance, and emotionality factors. Parametric or non-parametric tests were employed based on normality assumptions, and internal consistency was measured using Cronbach's alpha coefficient. Results revealed a significant decrease in statistics anxiety levels post-course ($p<0.001$). Scores across all Statistical Anxiety Scale factors (worry, avoidance, and emotionality) were reduced, demonstrating the effectiveness of hands-on training. Internal consistency improved across all factors, suggesting enhanced participant comprehension and confidence. The study highlights the impact of the applied Biostatistics course offered at Muğla Sıtkı Koçman University on reducing statistics anxiety. The integration of theoretical statistics with computer applications has enhanced the cognitive and emotional readiness of the study group to meet statistical requirements.

Keywords: Biostatistics, Statistics Anxiety, Applied Biostatistics, Biostatistics Course

Introduction

Biostatistics, a specialized branch of statistics, plays a crucial role in health research, serving as an essential discipline for generating scientific evidence (1). While statistics as a general field focuses on data analysis and interpretation across numerous disciplines, biostatistics deals with the complexities of biological and medical data. It involves determining the optimal sample size for studies, designing research methodologies, collecting data using appropriate sampling methods, and analyzing and interpreting the data to derive reliable conclusions in medical research. Biostatistical methods are essential to medicine, serving as the foundation for developing diagnostic and treatment strategies (2,3). These methods play a critical role in clinical trials, epidemiological research, and identifying disease risk factors, enabling the assessment of health outcomes and ensuring the safety and efficacy of medical interventions. Moreover, biostatistics informs health policy formulation, helps optimize healthcare resource allocation, and supports evidence-based clinical decision-making. By utilizing these statistical approaches, healthcare professionals can enhance the reliability and effectiveness of treatments, underscoring the pivotal role of biostatistics in advancing healthcare and improving patient outcomes (4,5).

Despite its undeniable importance, biostatistics often induces considerable anxiety among medical students and healthcare professionals (6,7). Statistics anxiety refers to the situational anxiety experienced while taking a statistics course or engaging in statistical tasks such as data collection, analysis, and interpretation of statistical results (8,9). This anxiety, often stemming from the perceived complexity of the subject, unfamiliarity with statistical methods, and lack of confidence in using statistical software,

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has been shown to obstruct learning, negatively impact academic performance, and limit students' capacity to apply statistical knowledge in real-world contexts. Given these challenges, there is a clear need for effective educational strategies to enhance learners' understanding of biostatistics and alleviate anxiety related to its application (10,11). Recent research indicates that biostatistics courses incorporating practical training with statistical software may not only enhance students' theoretical understanding but also alleviate their anxiety by fostering confidence in independently conducting basic analyses. This is particularly important for medical professionals engaged in scientific research and medical specialty students who are required to conduct studies, such as specialty theses (12,13).

This study aims to assess the impact of the Applied Biostatistics course on the statistics anxiety of medical specialty students enrolled in the course.

Material and Method

Muğla Sıtkı Koçman University Health Sciences Ethics Committee approved this study (Approval Reference Date and Number: 28.11.2024 / 145). The study population consists of all medical specialty students who attended the 'Applied Basic Level Biostatistics Course,' organized by the Division of Biostatistics within the Faculty of Medicine at Muğla Sıtkı Koçman University from September 2 to 4, 2024 (n=16). The Applied Basic Level Biostatistics Course spanned a total of 12 hours over three days and was delivered in a face-to-face format. Each statistical analysis method was first introduced along with its theoretical foundation, followed by a hands-on computer-based application of the respective method. The theoretical sessions were conducted over 30 minutes, whereas the practical sessions were allocated 40 minutes. The course covered fundamental definitions and concepts in Biostatistics, data classification, measures of central tendency and dispersion, and parametric and non-parametric statistical tests, including Student's t-tests, Mann-Whitney U test, Wilcoxon signed-rank test, chi-square tests, analysis of variance (ANOVA), and correlation analysis. At the beginning and end of the course, medical specialty students were provided with a link to the data collection form via Google Forms, which included items of SAS, their previous experiences with biostatistics (whether they had previously needed statistical knowledge, at which stage of their undergraduate education they had taken a biostatistics course, and whether they had previously attended a biostatistics course), as well as their expectations from the course.

Table 1. Scale items forming the factors in SAS (15).

Factor	Number of Items	Sample Item
WR	8	If I had to comment on statistical data in a course, I would be worried that I would make a fool of myself. (Items: 1, 5, 8, 10, 11, 12, 14, 16)
AV	4	When presentation topics are being assigned in the course, I would make sure that I receive a topic that doesn't involve statistics. (Items: 3, 4, 6, 17)
EM	5	I would be quite nervous if I were asked to explain a chart from a research report. (Items: 2, 7, 9, 13, 15)

Statistical Anxiety Scale (SAS)

The Statistics Anxiety Scale for Graduate Students was developed by Faber,Drexler,Stappert, et al. (14) and translated and adapted to Turkish by Güler,Teker and İlhan (15). The scale consists of three factors: Worry (WR) (8 items), Avoidance (AV) (4 items), and Emotionality (EM) (5 items), comprising a total of 17 items (Table 1). The scale items are rated on a four-point Likert scale, ranging from Strongly Disagree (1 point) to Strongly Agree (4 points). The minimum and maximum possible scores on the scale are 17 and 68, respectively, with higher scores reflecting greater statistics anxiety. Güler et al. (15) stated that the Turkish version of the scale is a valid and reliable instrument for assessing statistics anxiety in graduate students. The Cronbach's Alpha coefficient was calculated as 0.91, 0.83, 0.91 for the WR, AV and EM factors of the scale, respectively, and 0.96 for the overall scale.

Statistical Analyses

The statistical analyses were applied with SPSS (IBM Corp. Released 2020. IBM SPSS Statistics for Windows, Version 27.0. Armonk, NY: IBM Corp). Cronbach's alpha coefficient was calculated to measure the internal consistency of the SAS. The suitability of quantitative variables for normal distribution was tested with Shapiro-Wilk's test. Paired samples were compared by paired samples t-test if the samples fit a normal distribution, the by Wilcoxon signed-rank test, otherwise. Descriptive statistics for normally distributed quantitative variables were expressed as mean±standard deviation; otherwise, the median (25%–75% percentiles) was given. Qualitative variables were presented as frequency (n) and percentage (%) values. The statistical significance level was set at α=0.05.

Results

It was stated that 8 of the 16 medical specialty students who participated in the course - who were also working as assistants - needed statistical knowledge for data analysis in scientific studies during their medical specialty training. Six assistants

Table 2. Mean±Standard Deviation Values and Cronbach's Alpha Coefficients of SAS factors obtained before and after the Biostatistics course.

Factor	Statistic	Before the Course	After the Course
WR	$\overline{X} \pm$ SD	22.69±4.08	13.25±3.32
	Cronbach's Alpha	0.740	0.863
AV	$\overline{X} \pm$ SD	9.13±3.03	5.88±1.93
	Cronbach's Alpha	0.726	0.810
EM	$\overline{X} \pm$ SD	14.56±2.87	8.13±1.93
	Cronbach's Alpha	0.753	0.846
Overall	$\overline{X} \pm$ SD	46.38±8.46	27.25±6.57
	Cronbach's Alpha	0.865	0.931

$\overline{X} \pm$ SD: Mean±Standard deviation

indicated they had taken Biostatistics courses in Phase 1, three in Phase 2, three in Phase 3, and one in either Phase 1 or Phase when undergraduate. Consequently, two assistants stated they had received Biostatistics education in Phase 4 during their undergraduate medical training, while 12 reported taking it between Phase 1 and Phase 3. Out of the assistants who participated in the course, 14 had not attended any Biostatistics course during their specialty training, and one reported attending a Biostatistics course before. Only one participant did not have specific expectations from the course, while the remaining aimed to achieve a level of proficiency that would allow them to perform statistical analyses independently.

The mean and standard deviation values and Cronbach's alpha coefficients for the SAS factors obtained before and after the Biostatistics course are given in Table 2. The Cronbach's alpha values calculated for the WR, AV, EM factors and overall items before and after the course increased from 0.740 to 0.863, from 0.726 to 0.810, from 0.753 to 0.846 and from 0.865 to 0.931, respectively. This suggests that the assistants provided more consistent responses to the scale items after the course.

It is observed that the WR, AV, EM total and overall scores of the SAS before the Biostatistics course showed a significant decrease after the course (Table 3). The Applied Biostatistics course played an effective and significant role in reducing the statistical anxiety of the medical specialty students.

Table 3. Comparison of SAS Factors Before and After the Biostatistics Course

SAS Items	Before Biostatistics course	After Biostatistics course	Z / t	p
WR	22 (20-24.75)	13.50 (10.25-16)	-3.521	**<0.001**^{w}
AV	9 (6.25-11.75)	5.50 (4-8)	-2.928	**0.003**^{w}
EM	14.50 (12.25-16)	9 (6.25-10)	-3.521	**<0.001**^{w}
Overall	46.38±8.46	27.25±6.57	8.071	**<0.001**^{s}

Descriptive statistics are shown as median (25%-75% percentiles) or mean±standard deviation, w: Wilcoxon signed-ranks test, Z: Z test statistics, s: Paired samples t-test, t: t-test statistics

Discussion

Statistics anxiety is a critical barrier to academic success, particularly for health sciences students, in which statistical analysis is integral to research-based decision-making. This study examined the effect of the "Applied Basic Level Biostatistics Course" on medical specialty students at Muğla Sıtkı Koçman University. The outcomes underscore the importance of structured, applied training in reducing statistics anxiety and enhancing comprehension. Notably, the marked improvement in internal consistency (Cronbach's alpha) after the course suggests that students developed a clearer and more consistent understanding of biostatistical principles. This may indicate not only reduced anxiety but also a deeper cognitive processing of statistical knowledge.

The results align with prior studies emphasizing the value of integrating practical applications with theoretical instruction (16,17). Incorporating statistical applications into the course allowed students to bridge the gap between theoretical concepts and practical application, fostering confidence and reducing anxiety. This reflects similar observations by Chang and Lin (18) that interactive and applied educational strategies reduce learning-related fears. The reduction in anxiety scores was consistent with studies by Zeidner and Safir (19), who found that structured, focused learning environments significantly decrease anxiety levels. The conceptual framework underpinning the course at Muğla Sıtkı Koçman University, which emphasized both theoretical and applied learning, appeared to play a pivotal role in this outcome. Similar to the findings of Huang (20), our study also observed a notable reduction in students' statistics anxiety. This decrease can be attributed to the integration of theoretical knowledge with computer-based practical training, which helped address participants' expectations of failure and improved their confidence in performing statistical tasks. These results highlight the importance of targeted educational interventions in reducing statistics-related anxiety. Moreover, the course design, which allowed students to explore statistical software in a supportive learning environment, directly addressed the need for familiarity and practice, as emphasized by Pallant (21). The applied Biostatistics course allowed students to connect theoretical constructs with their application, leading to a significant decline in emotionality-related anxiety. The balanced integration of theoretical and applied learning strategies is critical not only for the acquisition of academic knowledge but also for reducing anxiety and other emotional barriers encountered during the learning process. Our study resembles those in the literature in terms of its limitations, particularly due to the high level of anxiety students feel towards statistics and the small size of the study group (9,22-

25). Therefore, the primary limitation of our study is the small size of the study group (n=16). However, this limitation arises from the focus on a specific group and the limited participant capacity of the course. Thus, the results reflect the outcomes of the course designed to reduce statistics anxiety. In the future, studies conducted with larger samples may enhance the generalizability of the results and provide a more comprehensive understanding of their effects on different groups. In this regard, our study serves as a pilot study for developing educational strategies aimed at reducing statistics anxiety.

Conclusion

The implementation of the Biostatistics course at Muğla Sıtkı Koçman University reduced the statistics anxiety of medical specialty students by lowering worry, avoidance, and emotionality scores. Therefore, based on the findings of this pilot study, it can be stated that the Biostatistics course is effective in developing both competence and confidence.

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Conflict of interest statement

The authors declare that they have no known competing financial or personal relationships that could be viewed as influencing the work reported in this paper.

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