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THE FEAR OF ARTIFICIAL INTELLIGENCE: DENTISTS AND THE ANXIETY OF THE UNKNOWN

YAPAY ZEKA KORKUSU: DİŞ HEKİMLERİ VE BİLİNMEYENİN KAYGISI

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ABSTRACT

Objective: Artificial Intelligence (AI) has the potential to improve patient care and treatment outcomes; however, it also raises concerns about job security, ethical issues, and the impact on the quality of care provided. It is important to investigate the attitudes and concerns of dental professionals towards AI to develop effective strategies for its implementation that ensure patient safety and quality of care while also addressing the concerns of dental professionals. This study aimed to explore the levels of AI anxiety (AIA) experienced by dentists and to investigate the influence of various factors.

Materials and Methods: Data were collected online from 328 dentists (116 males, and 212 females) regarding their age, sex, marital status, field of specialization, and years of professional experience. The levels of AIA among the participants were assessed using the Artificial Intelligence Anxiety Scale (AIAS).

Results: The Dentists participated in the survey, revealing a moderate level of AIA (65.60±28.55). The AIA levels were significantly higher in females compared to males (p<0.05). Prosthodontists exhibited the highest levels of AIA (75.63±34.86), whereas restorative dentists showed the lowest levels (44.63±12.50). AIA did not show any significant correlations with age or length of work in the profession (p>0.05). There were correlations between AIA and all sub-dimensions, as well as among the sub-dimensions themselves (p<0.01).

Conclusion: Although dentists experience moderate levels of anxiety toward AI, they must acquire the knowledge and skills required to effectively utilize this innovative technology for their benefit.

Keywords: Anxiety, artificial intelligence, artificial intelligence anxiety, dentists.

ÖZ

Amaç: Diş hekimliğinde Yapay Zeka (YZ), hasta bakımını ve tedavi sonuçlarını iyileştirme potansiyeline sahiptir, ancak aynı zamanda iş güvenliği, etik sorunlar ve sağlanan bakımın kalitesi üzerindeki etkisi hakkında endişeler doğurur. Bu nedenle, diş hekimlerinin endişelerini ele alırken aynı zamanda hasta güvenliğini ve bakım kalitesini sağlayan etkili stratejiler geliştirmek için diş hekimlerinin YZ'ye yönelik tutumlarını ve endişelerini araştırmak önemlidir. Bu çalışmanın amacı, çeşitli seçilmiş faktörlerin etkisini araştırırken aynı zamanda diş hekimlerinin yaşadığı YZ kaygı (YZK) düzeylerini araştırmaktı.

Gereç ve Yöntem Bu çalışma için diş hekimlerinden yaş, cinsiyet, medeni durum, uzmanlık alanı ve mesleki deneyim yılına ilişkin veriler çevrimiçi olarak toplanmıştır. Katılımcıların YZK düzeyleri Yapay Zeka Kaygı Ölçeği (YZKÖ) kullanılarak değerlendirildi.

Bulgular: Ankete 116 erkek ve 212 kadın olmak üzere 328 diş hekimi katılmıştır ve orta düzeyde YZK (65,60±28,55) ortaya çıkmıştır. YZK düzeyleri kadınlarda erkeklerden anlamlı olarak yüksekti. (p<0,05). Protez uzmanları en yüksek YZK seviyelerini (75,63±34,86) sergilerken, restoratif diş hekimleri en düşük seviyeleri (44,63±12,50) gösterdi. YZK, yaş veya meslekte çalışma süresi ile anlamlı bir ilişki göstermedi (p>0,05). YZK ile tüm alt boyutlar arasında ve alt boyutların kendi aralarında da korelasyon vardı (p<0,01). Cronbach's Alpha tüm maddeler için 0,96 idi.

Sonuç: Diş hekimleri yapay zekaya karşı orta düzeyde kaygı yaşasalar da, inovatif teknolojiyi kendi yararlarına etkili bir şekilde kullanmak için gerekli bilgi ve becerileri edinmeleri çok önemlidir.

Anahtar Kelimeler: Kaygı, yapay zeka, yapay zeka kaygısı, diş hekimleri.

INTRODUCTION

Artificial intelligence (AI) is advancing rapidly, and its impact on dentistry is uncertain. Dentists are anxious about the potential impact of AI on their profession, as AI can automate many of the tasks that dentists perform, such as diagnosing dental diseases and performing dental procedures. AI could lead to a decrease in the cost of dental care, as it could be a more cost-effective and efficient alternative (1). Additionally, AI can be used to analyze large amounts of data and to identify patterns that may not be visible to dentists (2,3). Thus, AI can lead to more accurate diagnoses and treatments, resulting in improved patient outcomes (4,5). However, AI is unlikely to completely replace dentists, as AI cannot provide the same level of care and empathy that a dentist can (6).

Dentists are increasingly turning to AI to help improve their practice (7-10). However, with this new technology comes a variety of anxieties that can affect dentists' comfort levels. This can be caused by several factors, including lack of training, unfamiliarity with new technology, and fear of the unknown. This fear can lead to a reluctance to adopt AI technology, which can hurt patient care. Without embracing new technologies, dentists may be unable to provide the best possible care to their patients. In addition, they may miss out on opportunities to improve efficiency and reduce costs.

Dentists may experience various anxieties related to AI, including fear of the unknown, uncertainty about the benefits of AI in their practice, fear of job loss due to AI, potential mistakes when using AI, and concerns about the security of their data. The negative implications of AI anxiety (AIA) can extend to both dentists and their patients, making it imperative to explore the underlying reasons for this anxiety. Hence, this study aimed to evaluate AIA levels among dentists and investigate the potential influence of various contributing factors.

MATERIALS and METHODS

The conformance of the study to the ethical guidelines of the Helsinki Declaration was approved by the Non-Interventional Clinical Research Ethics Committee of Biruni University (Date: 27.05.2022, No:2022/70-13). Based on the mean and standard deviation of the AIA level (76.30±27.87) in a previous study a minimum required sample size of 326 to achieve a power of 95% and a significance level (α) of 5% using the software R program (Version 4.1.3) (11).

This online descriptive study was carried out among dentists practicing in the province of Istanbul. Before participation, all potential participants were informed about the study and provided with online informed consent. By proceeding to and completing the online survey, participants implicitly gave their consent. The survey was designed using a Google Form and utilized a forced-choice format to minimize missing data. From June to July 2022, the survey was distributed electronically via email and WhatsApp. To ensure confidentiality, all participants were anonymized, and no personal information was collected.

The socio-demographic data on age, sex, marital status, field of specialization (i.e., general practitioner/dental specialties), and years of experience in the profession were collected from the participating dentists (n=328). The dentists' level of artificial intelligence anxiety was assessed using the AIA Scale (AIAS).

Artificial Intelligence Anxiety Scale

The AIAS was developed by Wang and Wang and adapted into Turkish by Terzi (12,13). The Cronbach's alpha reliability coefficient was 0.96 for the complete scale, which indicates that the tool is reliable and valid. The 7-point Likert type (strongly disagree-strongly agree) scale consists of 21 items and four sub-dimensions: learning, job replacement, sociotechnical blindness, and AI configuration. The Learning sub-dimension (L) assesses anxiety levels when learning about AI applications in one's career. The Job Replacement sub-dimension (J) measures the anxiety levels experienced by individuals who could potentially face job loss due to AI. The Sociotechnical Blindness sub-dimension (S) evaluates anxiety levels in those who do not fully understand that AI requires human cooperation and social institutions. The AI Configuration sub-dimension (C) measures anxiety levels in those who find AI techniques/products scary and intimidating. Scores on the scale range from 21 (lowest) to 147 (highest). Permission was obtained from the author, who adapted the scale into Turkish via e-mail.

Statistics

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS Inc., version 17, Chicago, IL, USA). The normality of data distribution was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Differences between two groups were analyzed using the Mann-Whitney U test, while differences between more than two groups were compared using the Kruskal Wallis test, followed by pairwise comparisons between every two groups using Bonferroni correction. The relationships between variables were analyzed using Pearson's correlation test. A p-value less than 0.05 was considered statistically significant.

RESULTS

All 328 dentists who were invited to participate completed the survey without missing any data. Of the respondents, 35.36% (n=116) were male and 64.64% (n=212) were female. The mean age of the participants was 29.79±7.64, and the mean length of work in the profession was 5.98±7.50 years. Most respondents (n=221, 67.38%) were single, while 30.79% (n=101) were married, and 1.83% (n=6) were either divorced or widowed. Of the participants, 66.77% (n=219) were general dentists, while the remaining 33.23% (n=109) were specialists in various fields, including endodontics (n=7), oral and maxillofacial radiology (n=5), oral and maxillofacial surgery (n=10), orthodontics (n=20), pediatric dentistry (n=14), periodontics (n=37), prosthodontics (n=8), and restorative dentistry (n=8).

Table 1 displays the mean scores for each item and sub-dimension of the questionnaire. Among the 21 items, the item with the lowest mean score (2.24±1.54) was "Taking a

Table 1: The mean scores of items and subdimensions in the questionnaire

Subdimension	Item	Mean±SD	Mean±SD
L	L1	2.63±1.63	
	L2	2.52±1.62	
	L3	2.50±1.62	
	L4	2.36±1.52	2.57±1.39
	L5	2.44±1.60	
	L6	2.24±1.54	
	L7	2.34±1.61	
	L8	3.54±2.00	
J	J1	3.15±1.78	
	J2	3.41±1.96	
	J3	3.37±1.98	3.30±1.68
	J4	3.45±1.97	
	J5	2.98±1.85	
	J6	3.45±1.91	
S	S1	4.42±1.97	
	S2	3.75±1.80	3.88±1.65
	S3	4.03±1.87	
	S4	3.32±1.90	
C	C1	3.28±1.92	
	C2	3.29±1.89	3.23±1.81
	C3	3.13±1.90	
Total			3.12±1.35

AI: Artificial intelligence, SD: Standard deviation, L: Learning subdimension; J: Job replacement subdimension, S: Sociotechnical blindness subdimension; C: AI configuration subdimension, AIA: Artificial intelligence anxiety

Table 2: Artificial intelligence anxiety levels according to gender, marital status, and specialty

		n	AIA (Mean±SD)
Gender	Male	116	59.62±26.99
	Female	212	68.86±28.92
	p=0.04 (Mann Whitney U-test)		
Marital Status	Single	221	58.67±32.54
	Married	101	54.26±29.14
	Other	6	81.83±24.96
	p=0.529 (Kruskal-Wallis test)		
Specialty	General Practioner*,#	219	68.92±28.86
	Endodontist	7	62.00±21.16
	Oral and Maxillofacial Radiologist	5	60.60±23.44
	Oral and Maxillofacial Surgeon	10	53.20±26.24
	Orthodontist	20	59.25±25.62
	Pediatric Dentist*,#	14	71.14±29.38
	Periodontist	37	54.37±26.98
	Prosthodontist	8	75.62±34.86
	Restorative Dentist	8	44.62±12.50
	p=0.014 (Kruskal-Wallis test)		

n: number, AIA: Artificial intelligence anxiety, SD: Standard deviation, *compared to restorative dentist (Bonferroni correction), # compared to periodontist (Bonferroni correction).

class about the development of AI techniques/products makes me anxious," while the item with the highest mean score (4.42±1.90) was "I am afraid that an AI technique/product may be misused."

The dentists in the study had a moderate level of AIA, with a mean score of 65.60±28.55. The AIA levels in females were found to be statistically significantly higher in females than males (p<0.05). However, there were no significant differences in the AIA levels based on marital status (p>0.05). Prosthodontists had the highest AIA levels (75.63±34.86), while restorative dentists had the lowest (44.63±12.50). AIA levels in general practitioners were significantly higher than those in restorative dentists and periodontists (p=0.01, p=0.002, respectively). Similarly, pediatric dentists had significantly higher AIA levels than restorative dentists and periodontists (p=0.019 and p=0.034, respectively) (Table 2).

Correlations
Table 3 presents the correlations among the sub-dimensions of the AIAS. Strong and moderate correlations were found between all sub-dimensions (p<0.01). Moreover, the AIA level exhibited significant and strong correlations with all sub-dimensions, including learning, job replacement, sociotechnical blindness, and AI configuration (p<0.01, with correlation coefficients of 0.827, 0.908, 0.844, and 0.840, respectively).

AIA did not show any significant correlations with either age or length of work in the profession (p>0.05). No statistically significant correlations were observed between any of the sub-dimensions and age (p>0.05). A weak and negative correlation was determined between the learning sub-dimension and length of work in the profession (p<0.05; r=-0.124). There was a strong correlation between length of work in the profession and age (p<0.01; r=0.966) (Table 3).

The Cronbach's alpha was 0.96 for all items, 0.942 for learning sub-dimension, 0.941 for job replacement sub-dimension, 0.899 for sociotechnical blindness, and 0.950 for AI configuration, indicating excellent reliability.

DISCUSSION

The present study is the first study that has revealed that dentists have moderate anxiety against AI. While a lot of studies have focused on AI anxiety in various occupational groups including health workers, none of them deal with dentists (11,13-15). Therefore, there is no data available to compare the results of our research with those of. Nevertheless, the results of the present study are consistent with the findings of other studies that have analyzed different populations.

Table 3: Correlations among AIA, AIAS' Sub-Dimensions, length of work in the profession, and age

	Mean±SD	AIA	Learning	Job replacement	Sociotechnical blindness	AI configuration	Length of work in the profession	Age
AIA	65.60±28.55	1	0.827**	0.908**	0.844**	0.840**	-0.028	-0.008
Learning	20.57±11.13	0.827**	1	0.609**	0.493**	0.563**	-0.124*	-0.103
Job replacement	19.81±10.10	0.908**	0.609**	1	0.779**	0.716**	-0.007	0.016
Sociotechnical blindness	15.52±6.61	0.844**	0.493**	0.779**	1	0.759**	0.063	0.073
AI configuration	9.69±5.45	0.840**	0.563**	0.716**	0.759**	1	0.046	0.053
Length of work in the profession	5.98±7.50	-0.028	-0.124*	-0.007	0.063	0.046	1	0.966**
Age	29.79±7.64	-0.008	-0.103	0.016	0.073	0.053	0.966**	1

AI: Artificial intelligence, AIA: Artificial intelligence anxiety, AIAS: Artificial intelligence anxiety scale, SD: Standard Deviation. *Correlation significant was at p<0.05 level (2-tailed), ** Correlation significant was at p<0.001 (2-tailed).

In a study conducted on family physicians in Turkey, the AIA was reported to be moderate (76.30±27.87), which is in line with our findings (11). The item L6 had the lowest average in both studies, while the item S1 had the highest. The sociotechnical blindness sub-dimension expresses anxiety arising from the inability to accept that AI is a system and always and only works with people and social institutions (16). Our findings suggest that like the general population, dentists perceive AI technology as a self-sufficient and advanced autonomous entity (13). Learning about AI can be instrumental in fostering more favorable attitudes towards this technology. Our study's low levels of anxiety regarding the learning sub-dimension are promising findings, consistent with those reported by Baser et al (11). This suggests that dentists may possess a general sense of competence and adaptability when it comes to learning and adopting new technologies and innovations, including AI. However, it is important to note that the low anxiety levels observed in the learning sub-dimension do not necessarily imply that dentists do not require education or training on AI. Dentists may still require education and training on the use of AI in dentistry to effectively integrate it into their practice and to provide high-quality care to their patients. Furthermore, factors such as age, experience, and familiarity with AI may influence the low anxiety levels noted in the learning sub-dimension.

In our study, no significant differences were found between sociodemographic variables, age and years of work experience, and AIA. These results are in line with those of previous studies (11,14,17). In a study evaluating the AIA of internal medicine nurses, no difference was found among four different age groups in terms of AIA (17). Thus, age does not seem to be a confounding factor regarding AIA according to the available literature. Since young people are more familiar with AI and use AI tools in daily life, AI concerns can be expected to be low (14,18). The present study was conducted on relatively young dentists who are part of the modern generations growing up with technology in their hands. This may be one of the reasons why the AIA levels were not high in our study. Future studies may need to explore other sociodemographic and contextual factors that may impact dentists' attitudes and perceptions related to AI.

This study also examined the differences in AIA levels based on sex and found that females had higher levels. However, available data on the impact of sex on AIA are inconclusive, and there is no consensus on this matter. Like our study, Terzi reported higher AIA levels in females (13). A possible explanation for this might be that males generally exhibit more positive attitudes towards AI technologies and show a greater interest in technological developments compared to females (14,18-20). On the other hand, there are also studies showing that there is no difference between the sexes in terms of AIA (11,14,17). One possible explanation is related to differences in gender roles and stereotypes, which may impact how males and females perceive and interact with technology. Females may have different expectations and experiences related to the use of technology compared to males, which may impact their attitudes and anxiety related to the use of AI in dentistry. For example, females may be socialized to be more cautious or risk-averse in new situations, which could contribute to higher levels of anxiety related to the use of new technologies like AI.

In our study, we observed correlations between AIA and all the sub-dimensions, as well as between the sub-dimensions themselves. This finding highlights the complex and multifaceted nature of AI anxiety in dentistry. Dentists may experience anxiety related to various aspects of AI, and these concerns may be interrelated and influence each other.

The finding that prosthodontists had the highest AIA levels could be attributed to several factors. The use of technology, including AI, is becoming increasingly common in prosthodontics, and prosthodontists may have more exposure to AI and its applications in their specialty compared to other dental specialists

(21,22). Restorative dentists, on the other hand, had the lowest AIA levels in this study, which may indicate a lack of awareness or interest in the potential impact of AI in their field. This could be due to several factors, such as a lack of exposure to AI technology, a perception that AI is not relevant to their practice, or a lack of understanding of the potential benefits and drawbacks of AI. Although the replacement of oral radiologists by AI remains a topic of speculation and ongoing research, the practitioners involved in this study did not exhibit a significant level of anxiety toward AI. However, the study's findings may be influenced by its small sample size of five participants. To ensure more representative results, further research with a larger sample is necessary.

The finding that AIA levels were significantly higher in general practitioners compared to restorative dentists and periodontists (with p-values of 0.01 and 0.002, respectively) warrants further discussion. One possible explanation for this could be that general practitioners are likely to encounter a wider range of dental problems, which may require them to use a broader range of AI technologies. As a result, they may feel more pressure to keep up with the latest AI advancements, leading to increased levels of anxiety. Another factor that may contribute to this finding is the level of training and experience in working with AI technologies. General practitioners may have had less exposure to AI during their training, making them less familiar and less comfortable with its use. In contrast, restorative dentists and periodontists may have received more specialized training in using AI technologies, making them more confident in their ability to use them effectively. Overall, this finding highlights the need for targeted interventions to address AIA-related anxiety, particularly among general practitioners, who may be more vulnerable to this issue. Such interventions could include increased training and education on AI technologies such as lectures, seminars, scientific meetings, and workshops, as well as initiatives to reduce the anxiety associated with their use. While basic AI courses are accessible in various health domains, they are frequently one-time events. Nevertheless, such training has been demonstrated efficacy in mitigating AI-related concerns (23,24). Despite prior calls for curriculum adjustments to accommodate AI in healthcare including dentistry, the literature lacks an evidence-based methodology to substantiate these suggestions (23,25,26). Prospective, comprehensive, and longitudinal research is imperative to address this lack of evidence.

The limitations of this study need to be acknowledged. First, the present study was conducted in a relatively small group of participants, although the sample size met the adequacy criterion. Yet, these findings cannot be extrapolated to all dentists. Secondly, the data from our study could potentially have been influenced by the subjective opinions and perceptions of the participants. This study did not focus on those factors that may affect AIA. The results therefore should be interpreted with caution. Lastly, while the AIAS was originally developed to measure public anxiety towards AI, its usefulness as an instrument for assessing AI-related anxiety exclusively among dentists may be limited due to its lack of specificity, relevance, and validation within the dental profession. Dentists could benefit from a customized assessment tool that addresses their distinctive concerns and anxieties related to AI in dentistry. Further research investigating the confounding factors of anxiety and attitudes towards AI and evaluating the effectiveness of continuing education sessions to eliminate these factors should be conducted with more dentists. The findings from such investigations can inform strategies to address dentists' concerns and facilitate the adoption of AI in dental practice.

CONCLUSION

Overall, it is important to recognize and address the anxieties that dentists may experience related to AI in dentistry, as these anxieties may impact their willingness and ability to use AI systems in their practice. By addressing these anxieties and promoting the benefits of AI in dentistry, we can support the adoption and successful integration of these technologies into dental practice, leading to improved patient outcomes and more efficient and effective dental care.

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