SAĞLIK BİLİMLERİNDE YAPAY ZEKA DERGİSİ
Journal of Artificial Intelligence in Health Sciences

Cilt|Volume: 4 • **Sayı|Issue:** 1 - Nisan|April 2024

Determination of Artificial Intelligence Awareness of Pharmacists in Edirne

Edirne'deki Eczacıların Yapay Zeka Hakkındaki Farkındalıklarının Belirlenmesi

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Makale Bilgisi | Article Information
Makale Türü | Article Type: Araştırma Makalesi | Research Article
Doi: 10.52309/jaihs.2024.21
Geliş Tarihi | Received: 02.09.2023
Kabul Tarihi | Accepted: 02.02.2024
Yayım Tarihi | Published: 30.04.2024

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Atıf | Cite As
Ergin AD, et al. Determination of Artificial Intelligence Awareness of Pharmacists in Edirne. Journal of Artificial Intelligence in Health Sciences 2024;4(1): 11-18. DOI:10.52309/jaihs.2024.21

Çıkar çatışması
Yazarlar herhangi bir çıkar çatışması veya finansal destek bildirmemişlerdir.

Finansman
Bu çalışma, Trakya Üniversitesi Bilimsel Araştırmalar Proje Komisyonu tarafından desteklenmiştir (Proje No: 2022/139).
This study was supported by Trakya University Scientific Research Project Commission (Project No: 2022/139).

Teşekkürler
Çalışmamızı destekleyen Trakya Üniversitesi Bilimsel Araştırmalar Proje Komisyonu ve Edirne Eczacı Odası'na teşekkür ederiz.

We would like to thank Trakya University Scientific Research Project Commission and Edirne Pharmacists' Association for supporting our study.

Etik Onay
Trakya Üniversitesi Tıp Fakültesi, Girişimsel Olmayan Bilimsel Araştırmalar Etik Kurulu
25.04.2022, 10/28 Sayılı Etik Kurul Kararı

Yazar Katkıları
Motivasyon / Konsept: ÖE, BSM, ADE
Çalışma Tasarımı: ÖE, BSM, ADE
Kontrol / Gözetim: ÖE, BSM, ADE
Veri Toplanması ve / veya İşlemesi: ÖE, BSM, BK, MK, İA, SS, ŞNŞ, RA, GG, MAE, AOE, HM, ŞK, ŞDG, ZSB, DTT, SG, FCS, AÖ, ADE
Analiz ve / veya Yorum: ÖE, ADE
Literatür incelemesi: ÖE, ADE
Makalenin Yazılması: ÖE, ADE
Eleştirel İnceleme: ÖE, BSM, ADE

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ABSTRACT

Background and Aims: Artificial intelligence (AI) is a system that imitates human intelligence to perform certain tasks and can re-learn by collecting processed information. This technology can open a new era, especially in terms of in-pharmacy time costs. This study aims to measure the perspective of community pharmacists in the central district of Edirne province on artificial intelligence technology and the level of integration of this technology into their profession.

Methods: This descriptive survey study was conducted with 25 pharmacists in the central district of Edirne. Pharmacists or pharmacist managers were included in the study by stating that they volunteered to participate in the survey, verbally and in writing.

Results: According to the obtained results, when the *Interest and Awareness* part is examined, positive answers constitute 50.1%, neutral answers 30.7, and negative answers 19.2%. When the *Usage Areas and Foresight* part is examined, positive answers constitute 41.62%, while neutral answers are 34.13% and negative answers cover 24.24%.

Conclusion: It is seen that pharmacists are interested in AI and awareness about AI is increasing among pharmacists. On the other hand, the survey showed that there is concern among pharmacists because of the changing job contents and creating employment problems.

Keywords: Artificial Intelligence, Awareness, Innovation, Pharmacy, Pharmacy 4.0,

INTRODUCTION

Machines and computers that imitate human behavior and the mechanism of the human brain are referred to as artificial intelligence (AI) [1,2]. Edward Fredkin, the director of Computer Science at the Massachusetts Institute of Technology (MIT), once stated, "There are three great events in history: the first of these is the creation of the universe. The second is the beginning of life. The third is the emergence of artificial intelligence." This statement underscores the significance of artificial intelligence [3].

AI is a field of computers connected to intelligent machine learning, mostly composed of intelligent computer programs that produce outcomes resembling those produced by human attention [2]. This process typically includes collecting data, creating effective mechanisms for using that data, illustrating precise or approximate conclusions, and making necessary self-corrections and adjustments. Artificial intelligence applications aim to understand the human mind and decision-making competence and combine it with machines and computer programs. AI entails gathering data, effective interpretation, self-corrections, and changes like the human brain [2,4]. There are different types of artificial intelligence, such as expert systems, artificial neural networks (ANN), machine learning (ML), and deep learning (DL). Even if these systems are called AI systems, they have small differences between them [5,6].

Disruptive technologies, such as artificial intelligence, positively affect the lives of individuals. From the point of view of the health sector, these new technologies are beneficial in increasing communication between health personnel and patients, improving treatment processes, increasing patient compliance, and facilitating administrative activities between health institutions. In particular, the use of artificial intelligence in the clinic makes it easier for healthcare personnel to make decisions in risky situations and can act as a virtual assistant. It has been observed that artificial intelligence has transformed the health sector in recent years [7]. Besides clinical applications, AI is becoming very popular in the pharmaceutical industry and healthcare [8]. AI and AI-based systems (ML, DL, etc.) facilitate drug discovery by calculating interactions with 3D protein structures. AI techniques are also used in the prediction of physicochemical properties, dissolution patterns, and pharmacokinetic specifications to eliminate devastating experiments and costs [8,9]. AI is also used for drug repurposing for the new application of old drugs. ML and DL-based algorithms scan molecules to target ideal disease-related proteins. To do this, publicly open chemical libraries (PubChem, ChEMBL) are used to shorten drug discovery times [8,9].

Pharmacy is one of the sub-stakeholders in the healthcare field. The World Health Organization defines four main functions of pharmacy services: 1. Preparation of drugs, quality control, distribution, administration, dispensing, and disposal of medications. 2. Offering efficient management of drug therapy, 3. Continuing to uphold and enhance professional performance, 4. Making efforts to increase the efficiency of the healthcare system and public health [10]. The job descriptions mentioned above require great organization and automation in pharmacy. For this reason, pharmacies are the most suitable environment for the implementation of artificial intelligence. In particular, machine learning can be actively used as a decision-support mechanism in stock management, pharmaceutical logistics, and personalized medicine. The time and energy wasted in traditional pharmacy services can be eliminated by artificial intelligence-supported robotics and automation systems, increasing the time that the pharmacist can dedicate to their patients. This period, in which disruptive technologies such as artificial intelligence are used in pharmacy, is called the era of Pharmacy 4.0, akin to the concept of Industry 4.0 [11].

While AI is spreading in industrial and clinical areas in pharmacy, pharmacy education needs to change to keep up with the shifting environment. To use AI effectively in the clinical and industrial applications governed by pharmacists, pharmacy education needs to be rearranged according to the needs of the time. In May 2021, The International Pharmaceutical Federation (FIP) released a global report called "Digital Health in Pharmacy Education" [12]. In this report, the education of the current and future pharmacy workforce, the necessity of integrating pharmacy education and digital health, and the adaptability of syllabi in faculties were described. According to this report, there were five digital health programs in the world, with four of them being

certificate-based and one being a master's program. After the publication of this report, the "Artificial Intelligence in Pharmaceutical Science" elective course was introduced in our faculty. In this course, AI and its usage areas were taught. After completing this course, a survey study was conducted with pharmacy students who took the course. This study aims to measure the perspective of community pharmacists in the central district of Edirne regarding artificial intelligence examples and the level of integration of these technologies into their professions.

MATERIALS AND METHODS

This descriptive survey study was conducted with 25 pharmacists to measure the usage rates and awareness of Artificial Intelligence in pharmacies in the Central District of Edirne Province. Pharmacists or pharmacist managers were included in the study with verbal and written consent. The ethical and scientific suitability of this research project was evaluated at the meeting of the Trakya University Faculty of Medicine Non-Interventional Scientific Research Ethics Committee dated 25.04.2022 and received permission with decision number 10/28.

The semi-structured questionnaire study was administered face-to-face to pharmacists. A section for free opinions, current suggestions, and concerns was added to the end of the questionnaire to allow pharmacists to provide additional insights on this issue. The survey questions were prepared by the researchers and consisted of two parts titled "Interest and Awareness" and "Areas of Use and Foresight." In the first part, questions were asked to determine whether pharmacists are aware of the artificial intelligence systems they use in their daily lives. The second part measured their views on the future of artificial intelligence applications. The questionnaire used is presented in Table 1.

In the evaluation of artificial intelligence usage rates and awareness among pharmacists, a total of 34 questions were asked, with 17 questions in each section, including Interest and Awareness and Areas of Use and Foresight. The questionnaire was structured in a 5-point Likert format, with responses ranging from (1) Strongly Disagree, (2) Disagree, (3) Neutral, (4) Agree, to (5) Strongly Agree, and the following responses were obtained. Results were considered positive for those who answered 4 or 5, neutral for those who answered 3, and negative for those who answered 1 and 2. Evaluations were made by calculating the percentages of these responses among the total answers. When the percentages of the given answers were below 70%, the results were evaluated negatively, indicating a need for improvement.

RESULTS

The survey questions and the obtained results are given in Table 1. When the Interest and Awareness section was examined in its entirety, the average of neutral and positive answers was found to be 30.7%, and 50.1%, respectively. These results showed us that the Interest and Awareness of AI among the pharmacists in Edirne province is positive. When Table 1 is examined, all of the pharmacists think that they are familiar with the concept of artificial intelligence (100%). When the obtained results are examined, the neutral and positive answers given to all questions - except Question 3 - are over 70%. This shows that pharmacists are aware of the use of artificial intelligence in their daily lives. On the other hand, pharmacists think that pharmacy employees do not have knowledge about artificial intelligence and do not use it (negative 45.06±11.01%). When only the positive-neutral answers are examined alone, the highest neutral percentage is in response to the question about where artificial intelligence applications are used in daily life. However, most of the pharmacists are neutral about their employees' knowledge of artificial intelligence. Pharmacists do not know the sources of theoretical and practical information about artificial intelligence applications that can be used in pharmacies (52%).

When the Usage Areas and Foresight section is examined, positive, neutrals, and negative responses constitute 41.62%, 34.14% and 24.24%, respectively. The approaches of pharmacists in Usage Areas and Foresight section regarding artificial intelligence are evaluated positive (~75.8%). This highly positive answer can be said that pharmacy professionals are familiar with AI because they use many software programs in pharmacy. They state that they actively use artificial intelligence in the operation of the pharmacy and that they are satisfied with this situation. Although these results are generally

pleasant, negative thoughts should be elaborated upon. These negative answers may be due to the dysfunctions of existing software programs and the fear that the profession will be taken over by artificial intelligence. In addition, pharmacists doubt the easy integration of pharmacies with artificial intelligence applications. Pharmacists are also neutral about whether universities provide the necessary information on these issues.

In addition to this, we reviewed additional comments of pharmacists as follows:

- We as a nation are not open to automation applications.
- It can increase unemployment.
- I fear the destruction of the entire pharmacy profession.
- Transportation and follow-up of patients can be facilitated.
- Artificial intelligence can take place in every field if universities and professional organizations support it.
- Necessary presentations can be made to increase awareness of artificial intelligence.

The current recommendations on artificial intelligence by pharmacists are summarized as follows:

- No AI application should be made without passing the ethical committee.
- Artificial intelligence training is insufficient, and should be improve.
- Courses should be given by universities. Studies on community pharmacies should be supported by professional organizations.
- Programs should be developed for all-level of society.

The current concerns on artificial intelligence by pharmacists are summarized as follows:

- Costs are an important issue and it will be very difficult to train the staff in this regard.
- There is a risk of monopolizing the whole profession.
- It is open to abuse.
- It is very difficult for patients to adapt.
- Issues such as the hiding of patient rights in pharmacies, how this process Works, and how artificial intelligence should be applied in pharmacies are subjects that are open to hesitation.

Table 1. Questionnaire and Results

	Negative%	Neutral%	Positive%
Interest and Awareness			
I think I have a general understanding of what artificial intelligence is.	0.00	20.00	80.00
I think I have knowledge about the practical uses of artificial intelligence in daily life.	4.00	32.00	64.00
I try to improve myself as much as I can in the field of artificial intelligence.	23.08	26.92	50.00
I think that I use artificial intelligence actively in my daily life.	17.39	52.17	30.43
Artificial intelligence applications developed in the field of pharmacy excite me.	23.08	34.62	42.31
I think pharmacy employees generally understand what artificial intelligence is.	37.50	41.67	20.83
I think that pharmacy employees are knowledgeable about the practical uses of artificial intelligence in daily life.	40.00	36.00	24.00
I think that pharmacy employees pay attention to their own development in the field of artificial intelligence.	57.69	19.23	23.08
I believe that artificial intelligence will be a technology that makes a difference in the industry in the next 10 years.	16.00	32.00	52.00
I know the resources to obtain theoretical and practical information about artificial intelligence applications that can be used in pharmacies.	28.00	52.00	20.00
Theoretical and practical information about artificial intelligence applications used in pharmacies should be given by professional organizations.	4.00	16.00	80.00
Theoretical and practical information about artificial intelligence applications that can be used in pharmacies should be given by universities.	0.00	20.00	80.00
I think that the effective use of data obtained by traditional methods is important for artificial intelligence studies.	8.33	16.67	75.00
I am aware of the concept of "Corporate Entrepreneurship".	16.00	24.00	60.00
I support pharmacy employees to be on the developer side of artificial intelligence.	8.00	28.00	64.00
I like to chat about artificial intelligence.	24.00	40.00	36.00
Usage Areas and Forecast			
I would like to be on the developer side of an artificial intelligence application.	24.00	36.00	40.00
I think that value can be created with artificial intelligence in my field.	4.00	44.00	52.00
The pharmacy is ready for the integration of artificial intelligence applications.	48.00	36.00	16.00
I am sufficiently aware of the uses of artificial intelligence in pharmacy.	26.92	38.46	34.62
We use artificial intelligence applications in pharmacy operation.	28.00	32.00	40.00
We make use of artificial intelligence applications in pharmacy stock control.	28.00	16.00	56.00
We make use of artificial intelligence applications in pharmacy patient follow-up and drug interactions.	25.00	20.83	54.17
I think that artificial intelligence applications used in the pharmacy accelerate the process.	20.00	16.00	64.00
The pharmacy is making sufficient investments in artificial intelligence applications.	40.00	44.00	16.00
Pharmacy managers are sufficiently aware of the use of the relevant subject.	20.00	64.00	16.00
The pharmacy is open to improvements in the storage and processing of information obtained through traditional methods.	4.17	25.00	70.83
I believe that artificial intelligence applications used in the pharmaceutical industry should increase in number.	4.00	28.00	68.00
Artificial intelligence applications help us in the functioning of the pharmacy.	12.00	24.00	64.00
The widespread use of artificial intelligence applications in pharmacies may create legal violations.	0.00	44.00	56.00
The widespread use of artificial intelligence applications in pharmacies may create ethical violations.	4.00	56.00	40.00
Pharmacy employees are sufficiently encouraged to have relevant knowledge.	52.00	28.00	20.00
Professional organizations give us the necessary information and advice on the relevant subject.	48.00	24.00	28.00
Universities provide us with the necessary information and advice on the relevant subject.	48.00	40.00	12.00

DISCUSSION

Artificial intelligence (AI) is increasingly gaining popularity in the healthcare sector, including disease diagnosis, and the enhancement of pharmacy services, stock management, and product recommendations. Despite this increasing popularity, there is limited research on the use of artificial intelligence in pharmacy services. This study aims to assess the perspectives and awareness of pharmacists regarding artificial intelligence in the central district of Edirne province.

In a 2018 survey conducted in the United Kingdom with 2103 general consumers, the findings showed that 90.1% of consumers had some knowledge about AI, but only 8.4% considered themselves experts on the topic. More than half (62%) of the respondents had never interacted with or used an AI program, while 23% were unsure about their experience with AI. Only 15% claimed to have interacted with or utilized an AI application in the past. These results suggest that while AI is known, there is still some ambiguity and lack of understanding about it among the general public. It is believed that AI technologies have become more visible in the years following this survey, and efforts should be made to reduce ambiguity and improve public understanding of AI.

In a study conducted in China during the Covid-19 pandemic, an online hospital offering artificial intelligence-based pharmacy services was created. This online hospital introduced an artificial intelligence-supported pharmacy service module with features such as online drug catalog search, prescription preview by artificial intelligence, drug distribution, and artificial intelligence-based drug consultation. Among the patients who used this system, 86% preferred the "drug distribution" mode. Additionally, 48.83% of patients applied for drug counseling services outside of working hours. This study emphasized the benefits of AI-based pharmacy services, including safe and rational drug use, time and cost savings for patients, and its importance in the prevention and control of the COVID-19 pandemic. In the current study, over half (54.17%) of the pharmacists reported benefiting from artificial intelligence applications in patient follow-up and drug interactions in the pharmacy. Furthermore, 64% of pharmacists believed that artificial intelligence would accelerate the process of pharmacy services.

A survey conducted in the USA with 10,260 participants found that 37% of Americans were "more concerned than excited" about the increasing daily use of AI. Additionally, 45% of respondents expressed equal levels of concern and excitement. Their main concerns revolved around potential job loss, privacy issues, and the possibility that AI would eventually outperform humans in various skill sets. These concerns were consistent with the findings of the current study.

In other countries, AI has been successfully employed in telepharmacy and stock management. Major pharmaceutical supplier companies such as McKesson, Liberty, Winpharm, PrimeRx, and WinRx have found AI to be highly beneficial in stock management. Developed algorithms can predict consumption rates with 90% accuracy, allowing pharmacists to place orders before running out of stock. This system can also be implemented in Turkish pharmacies, enabling pharmacists to analyze drug consumption data and formulate effective strategies to increase profitability.

A systematic review of artificial intelligence applications in pharmacy highlighted that simple AI programs, considered an early form of artificial intelligence, are already in use in pharmacies worldwide, referred to as pharmacy management systems. The review suggested that by leveraging data collected from patient systems in pharmacies and external data systems, combined with artificial intelligence, patient-oriented medicine can be prioritized. This approach allows patients to benefit more from pharmacists in public health services, ultimately increasing the efficiency of pharmacy operations. A 2022 independent pharmacy trends report published by Prescryptive Health, based on a survey of 341 pharmacy owners and decision-makers across the USA, found that using AI technology wisely could improve the total profitability of pharmacies (91%) and enhance the patient experience (89%). These findings align with the results of the current study, where 58% of pharmacists believed that artificial intelligence technology would make a difference in the pharmaceutical industry within the next 10 years, and 68% believed that the number of artificial intelligence applications in

the pharmaceutical industry should increase.

It is expected that the new generation of AI users in healthcare, including medicine, pharmacy, and dentistry students, will be familiar with AI technologies. A 2018 survey on undergraduate medical students' awareness of AI in radiology and medicine found that 77% and 86% of respondents believed that AI would revolutionize and improve radiology and medicine, respectively. However, students did not believe that AI would replace human radiologists and clinicians (82.9% and 91.6%). Additionally, 60% of students did not express worry about AI developments. In line with this, pharmacists in the current study reported a good level of knowledge about artificial intelligence (80%) and expressed concerns about their employees' knowledge of AI. This awareness among pharmacists is encouraging, as it indicates that healthcare professionals are cognizant of developing technologies.

In conclusion, it is predicted that artificial intelligence technologies will have a significant impact on pharmacies in the future, streamlining pharmacy operations. To achieve this, pharmacists should receive more information about artificial intelligence, and training in artificial intelligence models that can benefit pharmacy services should be provided. Artificial intelligence training courses would enable pharmacists to address pharmacy-related challenges and harness the benefits of AI. Academic and field studies are essential to increase interest and awareness among pharmacists, and further research is needed to fully understand the advantages of these technologies in pharmacy settings.

CONCLUSION

Pharmacy is a profession that requires multidisciplinary skills, where healthcare services are directly provided to the public. Changing paradigms in various occupations have been necessitated by technological advancements, and pharmacy is no exception, especially given the changes brought about by the pandemic. As a result, artificial intelligence applications, which have permeated all aspects of our lives, are finding their place in the pharmacy profession. It has become essential for pharmacists to be knowledgeable about these applications in order to keep pace with the evolving world and advance in the profession. In this context, this survey study was conducted to assess the knowledge and opinions of pharmacists, who are practitioners in our field, regarding artificial intelligence.

This study examined the knowledge levels of pharmacists in the province of Edirne regarding innovations related to artificial intelligence under two main categories: a) Interest and Awareness, and b) Areas of Use. When the results are analyzed, it is found that approximately 50% of the pharmacists responded positively in terms of interest, awareness, and utilization areas, viewing these practices as positive and supportive. The negative responses were around 20% for both categories, suggesting that this might be due to concerns or anxiety. In general, when examining the responses, it can be concluded that the opinions of pharmacists regarding artificial intelligence mostly fall within the positive to neutral range. Despite the positive aspects, AI appears to introduce some ambiguity among pharmacists.

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