A Research on the Perceptions of Individuals and Health Professionals about the Wearable Technologies Used In Healthcare Services

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ABSTRACT

The aim of this study is to provide information about wearable technologies used in healthcare services, to make a literature review about the accuracy of data obtained from these technologies, and to reveal the perceptions of individuals and healthcare professionals about using of wearable technologies in healthcare services. In this context, firstly, the literature regarding the wearable technologies used in health services and the accuracy of the data obtained from them were examined. Then, an online questionnaire was prepared by the researchers regarding the usage levels of wearable and traditional digital technologies and the accuracy of the data obtained from these technologies. The sample of the study consisted of 439 participants, 137 of whom were healthcare professionals. According to the results, 64.9% of the participants used smart phones to monitor their health indicators. Only, 9.6% of participants reported that they used smart watches while 9.8% of participants reported that they used smart wristband. 65% of the healthcare professionals recommended traditional digital devices to their clients for monitoring their health indicators. 82.5% of the healthcare professionals reported that they would trust more the data obtained from pulse while only 5.1 of the healthcare professionals reported that they would not trust the data obtained from traditional digital devices nor wearable devices. The responses of the participants regarding the usage of wearable technologies and digital devices were differed significantly according to participants' profession, education, and age groups ($p < 0.05$).

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INTRODUCTION

Wearable technologies become more and more important every day with the development and digitalization of technology (Lou, Wang, Jiang, Wei, & Shen, 2020). The production of these technologies has increased tremendously in recent years, leading to their usage becoming widespread and spreading to more industries (Fuller et al., 2020; Saleem et al., 2017). Wearable technologies provide many facilities in the areas where they are applied (Kristoffersson & Lindén, 2020). Their economic effects cannot be ignored in Turkey as well as in all countries. According to 2019 statistics of Turkish Information Technologies and Communication Authority, 77% of population use smartphones in Turkey. 9% of population use wearable technology such as wristbands and smart watches and 71% of population between the ages of 16 and 24 want to use wearable technology. The wearable technology market has grown by 55% until 2020. The total sales of wearable devices, which were 3.3 billion in 2020, is expected to reach 5 billion by 2026. The global size of the remote healthcare market in 2018 was $ 34.28 billion. It is estimated that it will be $ 185.66 billion in 2026 (Turkish Information Technologies and Communication Authority, 2020).

Wearable technologies provide continuous monitoring of physiological and biochemical parameters as well as human physical activities and behavior throughout daily life (Purohit, Kumar, Mahato, & Chandra, 2020). The smartphone is often used for information collection, storage, monitoring, and transmission to a remote server for analysis (Li, Ma, Chan, & Man, 2019). Big data produced by wearable devices is both a challenge and an opportunity for researchers who can apply more artificial intelligence techniques to these data in the future (Chawla, 2020; Din & Paul, 2019). It can directly influence clinical decision-making (Haghi & Deserno, 2020). Some researchers have shown that wearable technologies can increase the quality of patient care while reducing the cost of care, such as out-of-hospital patient rehabilitation (Kakria, Tripathi, & Kitipawang, 2015). Wearable devices save time and they allow many tasks to be done at the same time. In addition to these advantages, they have some disadvantages such as having a distracting potential, being expensive, needing different platforms to function properly, having technical limits such as size and battery capacity, difficulty in ensuring privacy and data security (e.g., Spann, 2016, Kitanin, 2016).

Although the use of wearable technologies is widespread, there are still few studies on the usage rates. It is also important to determine the perceptions of patients and healthcare professionals towards the use of data obtained from wearable technologies in health services. Because, variables such as individuals' belief in the accuracy of the data obtained from wearable technologies and the use of these data in the early diagnosis and treatment process will also affect the use of these devices. More importantly, in order to prevent social isolation during the COVID-19 pandemic, it has begun to be compulsory for distance education and remote work. It has also become more important to monitor patients remotely for hospitals with the highest contamination during this period. Follow-up of chronic diseases is always very important. With the use of wearable devices, it will be possible to monitor these patients remotely. However, these devices have some challenges such as being expensive, needing internet access, and difficult adaptation of elderly patients to technological devices. According to Mosconi et al. (2019), perceptions of patients about monitoring symptoms and communicating with the physicians on eHealth applications are rarely analyzed by previous studies. In addition, there is limited study about perceptions of healthcare professionals on wearable technology. For example, Maskara et al (2017), Oh et al (2019), and Abdullah & Fakieh (2020) have investigated the perceptions of healthcare professionals about implementation of artificial intelligence. Besides, Jacomet et al. (2020) determined the both patients' and physicians' perceptions of eHealth. However, these studies do not provide us with perception about usage of wearable technologies. Therefore, our study aims to determine the usage levels of wearable and traditional digital technologies, to determine the participants' and healthcare professionals' perceptions about the using wearable technologies in health services and their perceptions about reliability of the data obtained from these technologies.

1.1. Literature Review

Wearable technologies can be defined as mechanical and technological devices that can be worn by humans (Liu & Han, 2020; Zhu & Pham, 2020). Wearable technologies transmit the data they receive from the human body via their sensors to smartphones via wireless connection (Yue, Voronova, & Voronov, 2020). Many wearable technology products have both high access speed and comfort, and contain unlimited information networks and types (Zhu & Pham, 2020).

Wearable technologies have the potential to provide continuous, real-time physiological information through dynamic, non-invasive measurements of biochemical markers in bio fluid such as sweat, tears, saliva and interstitial fluid through biosensors (Kim, Campbell, de Ávila, Wang, 2019; Kristoffersson & Lindén, 2020, Li & Wen, 2020; Khan, Parkinson, Grant, Liu, & Mcguire, 2020). Usage areas of these products are generally health products, textile products and consumer electronics (Kılıç, 2017). It is used in many products such as smart watches, smart shoes and

clothes, smart wristbands and jewelry, smart glasses (Lou et al., 2020). In addition, there are studies on products such as wearable body parts, miniature sensors, devices to extend life-span - nanoparticles (Haghi & Deserno, 2020). These products are used in many diverse fields such as health, education, industry, tourism, military, information exchange and entertainment. In the health sector, it is mainly used for activity and exercise tracking, heart rate determination and electrocardiogram monitoring, respiratory rate and oxygen saturation measurement, blood pressure detection, sleep habits, detection of sudden movements of the body, and even monitoring the emotional state of the person ((Fuller et al., 2020; Greiwe & Nyenhuis, 2020; Miyaji et al., 2020; Muthu et al., 2020; Sana et al., 2020)). (Purohit, Kumar, Mahato, & Chandra, 2020).

Wearable technology products have the potential to offer innovative solutions for healthcare problems. It is divided into three categories according to their roles in the healthcare industry (Wu & Luo, 2019): (1) disease prevention and health protection; (2) patient management, and (3) disease management. Although the use of wearable technologies is promising in healthcare, large cohort validation studies are needed to increase reliability and support clinical acceptance. With the use of wearable technologies, accurate and reliable real-time acquisition of physiological information will have a wide impact on our daily lives (Kim, Campbell, de Ávila, Wang, 2019).

The accuracy, reliability, and validity of data obtained from wearable devices are important (Piwek, Ellis, Andrews, Joinson, 2016). These devices are marketed under the motto that they will help improve overall health and wellness. However, most manufacturers offer no empirical evidence to support the effectiveness of their products (Piwek, Ellis, Andrews, Joinson, 2016). Recent comparisons between various wearables to monitor physical activity have shown that there are large variations in accuracy between different devices - with margins of error up to 25% (Lee, Kim, Welk, 2014; Case, Burwick, Volpp, Patel, 2016). This is a serious inconsistency and reflects the problems witnessed in the medical applications market. Lack of reliability is a serious hurdle that must be addressed long before a device can be evaluated for any medical application (Piwek, Ellis, Andrews, Joinson, 2016).

In this section, information will be given about the reliability of four main measurements obtained from wearable devices. These are heart rate and electrocardiogram (ECG), blood pressure, blood oxygen saturation, and step count. Examples of the accuracy of these technologies will be given from the studies conducted in the current literature:

Heart rate: Wearable devices are frequently used to monitor heart rate, especially in physical activity (Bent, Goldstein, Kibbe, & Dunn, 2020). Although the use of wearable devices for heart rate monitoring is common practice, it is unusual to use information obtained through such devices in the context of health and clinical decision-making (Jin, Adams, Cocco, Martin, & Palmer, 2020). Because doubts about the reliability and accuracy of the data obtained from these devices make it difficult to use them in the health services. Therefore, a number of questions are asked: how reliable and accurate is the data from the biometric sensors of these devices? Can any of these be used in healthcare? (Jin, Adams, Cocco, Martin, & Palmer, 2020; Gonçalves, Leitão, & Carvalho, 2017).

With increased computing capacity, storage capacity and ubiquitous connectivity, smartphones enable individuals to actively monitor their health (Nwagwu & Areo, 2020). Physicians recommend to use wearable devices to detect early signs or cardiac abnormalities in cardiac patients. For example, atrial fibrillation is the most common cardiac disorder and can be asymptomatic. Most patients are not diagnosed with atrial fibrillation until their condition has worsened to the degree of heart attack, angina, stroke or heart failure (Appelboom et al., 2014). In a study, AliveCor's ECG device, which can be carried in a pocket, was compared with a standard 12-Lead ECG to investigate whether it is suitable for diagnosing silent atrial fibrillation. According to the results of this research, it was found that AliveCor's ECG device provides accurate and reliable data (Paton, Hansen, Fernandez-Luque, & Lau, 2012).

In another study, an analysis was performed using an approved clinical device (ECG) to evaluate the accuracy of heart rate obtained from the Microsoft Band2 device (a smart watch) (Gonçalves, Leitão, & Carvalho, 2017). According to the results of this study, under certain conditions, Microsoft Band2 provides valid information for use in clinical practice in relation to the evaluation of RR interval and cardiac frequency (Gonçalves, Leitão, & Carvalho, 2017).

Another study investigated the role of data obtained from smartphones that monitor the heart rate of patients in China in early diagnosis. In a project called "Wireless heart health program", 11,000 patients in rural areas of the country benefited from wireless healthcare. In this project, smartphones with heart rate sensors were used. These smart phones were connecting to 96 local physicians who could send and call patients using these phones. In addition, physicians were able to analyze the data received from patients and send feedback via these phones. As a result of this project, it was announced that 1,100 patients in the experimental group controlled by health sensors had serious cardiovascular problems (Carey, Klotz, & Kenny, 2015).

Blood pressure: European guidelines on the prevention of cardiovascular diseases recommend frequent blood pressure monitoring to prevent coronary disease (Ton, Martin, Blumenthal, & Blaha, 2013). In

addition, telehome monitoring has been shown to improve the quality of care in patients with cardiovascular diseases (Chandrasekaran, 2010). Today, sensors with very advanced technology are produced to facilitate the management of hypertension and congestive heart failure (Appelboom et al., 2014). One of them is the smart watch named InBodyWATCH. A research was conducted using a manual blood pressure measurement device and a smart watch, InBodyWATCH (Moon et al., 2020). Blood pressure was first measured three times with the InBodyWATCH, before and then blood pressure was measured four times using a manual sphygmomanometer. The blood pressure value obtained from the InBodyWATCH was compared to the more recent values of the previous and subsequent manual blood pressure measurement. The InBodyWATCH has been validated with accuracy (reported as 97.1%) compared to a manual sphygmomanometer (Moon et al., 2020).

Oxygen Saturation: Oxygen saturation values are important in patients with chronic lung disease, sleep apnea disorder, infection diseases such as Covid-19 or in monitoring the performance of athletes. Lauterbach et al. (2020) analyzed oxygen saturation values at different altitudes by comparing peripheral blood oxygen saturation (SpO2) taken from a Garmin fēnix® 5X Plus watch with measurements taken from a standard medical pulse oximeter. The reliability of the device was tested by repeating each measurement multiple times for each participant in a wide variety of environmental conditions. It showed a 3.3% deviation for SpO2 measurements taken at an altitude of 12,000 ft on the Garmin fēnix®. Average differences in SpO2 measurements were smaller at levels below 12000 ft altitude. Data from the study suggest that the Garmin fēnix® watch could be a suitable device for monitoring SpO2 in most ambient conditions.

Step count: Many smartphone apps and wearable devices have the ability to track step counts (Fuller et al., 2020). Step counts are often used to obtain other physical activity metrics such as distance or calories burned (Chong, Guo, Deng, & Woo, 2020). Fuller et al. (2020) conducted a meta-analysis study that examined nine different brands of commercial wearable devices and included 158 publications. Fitbit was the most researched brand. The study revealed that Fitbit, Apple and Samsung watches measure the steps accurately. Apple Watch and Garmin were the first two devices to give the most accurate results in measuring step count. For step counting, in controlled laboratory environments, a higher proportion of the devices showed accuracy and this was within a more acceptable accuracy range compared to free living conditions. In general, data from smartphones and watches were found to be either slightly lower or slightly higher than the observed step numbers (Fuller et al., 2020). In the light of the data in this meta-analysis, wearable devices and smart phones can be considered as alternative options for tracking step counts.

MATERIALS AND METHODS

This study was designed as descriptive to determine the utilization rates of wearable health technologies.

2.1. Sample

The study sample consisted of participants aged 18 years or above residing in Turkey. The sampling methods used are convenience sampling method and the snowball sampling method. Online survey was submitted to participants and requested to forward the link to other acquaintances over the age of 18.

439 people participated in the study. 31.2% (n = 137) of the 439 participants are healthcare workers. It was determined that 171 participants answered socio-demographic questions on age, gender, and education level, but 268 participants did not provide a response to these questions. The vast majority of these 171 participants (n = 146, 85.4%) were female, while 14.6% of them are male (n = 25). The average age of the participants was 26.54 ± 7.83; age range of 18 to 58 years. 52% of the participants (n = 89) were in the 18-25 age group, 32.2% (n = 55) were in the 26-33 age group, and 15.8% (n = 27) were in the 34 and above age group. When the educational status was assessed, 12.3% (n = 21) of the participants were high school graduates, 67.3% (n = 115) were university graduates and 20.5% (n = 35) were post-graduates.

2.2. Data Collection Tool and Process

The data were collected between December 1, 2020 and January 15, 2021 through an online questionnaire prepared by the researchers. The items in the questionnaire were prepared by the researchers. In the introduction part of the questionnaire form, information on purpose of the research, the voluntary participation and the confidentiality of the data of the participants was provided. Subsequently, questions about the usage level of wearable and digital technologies were included in the first section of the questionnaire. These questions are:

1. Select the devices that you use to monitor your health indicators.

2. How do you record measurements related to your health such as weight, blood pressure, blood sugar, oxygen level?

3. Would you like to regularly record and monitor your health-related values such as weight, blood pressure, blood sugar, oxygen level?

4. Would you consider online examination and follow-up opportunities for simple health problems or some chronic diseases?

5. Would you prefer monitoring patient remotely based on data obtained from wearable and digital devices (such as smart watches, smart wristbands, digital measurement devices)

In the second section of the survey, items about wearable devices concerning healthcare professionals was included. These are:

1. Are you a healthcare professional?

2. Which device would you recommend to your clients for signs monitoring?

3. What wearable devices data do you trust more?

The last section of the questionnaire involves socio-demographic characteristics of the participants, i.e., age, gender and educational status.

2.3. Data analyses

SPSS 22 statistical program was used to assess the data. In determining the descriptive characteristics of participants; percentage (%), frequency (n), arithmetic means and standard deviation values were used. The differences in the responses provided for wearable technologies according to profession, age groups, gender and education groups were analyzed using Chi-Square test.

RESULTS

Results are given under three headings. In the first part, the answers given by 439 participants to the questions regarding the use of wearable technologies were assessed. In the second part, the opinions of only healthcare professionals (n = 137) about wearable devices were assessed. In the third part, the significance in differences of the participants' responses to the use of wearable technologies and digital devices according to their socio-demographic characteristics was analyzed.

3.1. Descriptive Data on the Usage of Wearable Technologies and Digital Devices

Based on Table 1, 64.9% of the participants stated that they used smart phones to monitor their health indicators. While 23.9% of the participants stated that they did not use any digital scale, 23.9% of the participants stated that they used them. 20.3% of the participant stated that they used digital blood pressure device. To the question “how do you record measurements related to health such as weight, blood pressure, blood sugar, oxygen level?’, a great majority of the participants (80.6%) answered “I do not record and follow up, I take random measurements”. To the item ‘would you like these health-related data to be recorded and monitored regularly?”, 66.3% of the participants gave an affirmative response. 56% of the participants stated that they could recommend and use online examination and follow-up facilities for simple health problems or some chronic diseases. Only 4.8% of the participants stated that the data obtained from wearable and digital devices cannot be used in remote patient monitoring.

Table 1. Descriptive Data on the Usage of Wearable Technologies and Digital Devices

Variables		n	%
Select the devices you use to monitor your health indicators.	Smart phone	285	64.9
	Smart watch	42	9.6
	Smart wristband	43	9.8
	Digital blood pressure device	89	20.3
	Digital scale	105	23.9
	Blood pressure measuring device	22	5.0
	None	105	23.9
How do you record measurements related to your health such as weight, blood pressure, blood sugar, oxygen level?	Writing on a note by hand	17	3.9
	Save on smart phone	68	15.5
	I do not record or monitor. I measure randomly.	354	80.6
Would you like to regularly record and monitor your health-related indicators such as weight, blood pressure, blood sugar, oxygen level?	Yes	291	66.3
	No	148	33.7
Would you consider online examination and follow-up opportunities for simple health problems or some chronic diseases?	Yes, I recommend / use	246	56
	No, I would not recommend /or use	44	10
	Undecided	149	34
Data obtained from wearable devices (such as smart watches, smart wristbands, digital measurement devices) used for remote patient monitoring…	Can be used	199	45.3
	Can be used in certain diseases	219	49.9
	Can not be used	21	4.8

3.2. Opinions of participants from health care workers on the usage of wearable and digital devices

65% of the healthcare staffs participating in the study recommended traditional digital devices to their clients for sign monitoring. 36.5% recommended smart watches, 28.5% recommended smart wristbands and 24.8% suggested using biosensors (Table 2). According to 82.5% of the healthcare staffs reported that they would trust more the data obtained from pulse. However, only 5.1 of the healthcare staffs reported that they would not trust the data obtained from traditional digital devices nor wearable devices.

Table 2. Opinions of participants from health care workers on the usage of wearable and Digital Devices (n=137)

		n	%
Which device would you recommend to your clients for sign monitoring?	Traditional digital devices	89	65
	Smart watch	50	36.5
	Smart wristbands	39	28.5
	Biosensors	34	24.8
	None	11	8
Which data from the above devices would you trust more?	Oxygen level	74	54
	ECG	46	33.6
	Blood pressure	66	48.2
	Blood sugar	60	43.8
	Pulse	113	82.5
	I trust none	7	5.1

3.3. Chi-Square analysis

The differences in the responses of the participants regarding the use of wearable technologies and digital devices according to their socio-demographic characteristics were analyzed using Chi-square test. As a result of the Chi-square analysis performed, it was found that the responses obtained to the question "Considering online examination and follow-up opportunities for simple health problems or some chronic diseases" differed statistically according to the status of being a healthcare professional ($p < 0.01$) (Table 3). 16% of the healthcare personnel stated that they would not consider / recommend online examination and follow-up opportunities for simple health problems or some chronic diseases. 27.7% of them stated that they were indecisive. 7.3% of the

participants who are not health personnel stated that they would not consider / recommend online examination and follow-up opportunities for simple health problems or some chronic diseases. 36.8% of them stated that they were indecisive.

Table 3. Comparison of the responses obtained to the item concerning the consideration or recommendation of online examination and follow-up opportunities based on healthcare professional status

		Can you consider online examination and follow-up opportunities for simple health problems or some chronic diseases?					
Are you a healthcare staff?		Yes, I recommend / use	No, I would not recommend / use	Undecided	Total	Chi-Square	p
Yes	n	77	22	38	137	9.497	0.009
	%	56.20%	16.10%	27.70%	100.00%		
No	n	169	22	111	302		
	%	56.00%	7.30%	36.80%	100.00%		
Total	n	246	44	149	439		
	%	56.00%	10.00%	33.90%	100.00%		

It was determined that the answers to “the use of data obtained from wearable and digital devices (such as smart watches, smart wristbands, digital measuring devices) for remote patient monitoring” showed statistically significant difference ($p < 0.05$) (Table 4). When Table 4 is analyzed, it is seen that the difference between the groups is due to the graduate status of participants.

Table 4. Comparison of the situation of being able to use the data obtained from wearable and digital devices for remote patient follow-up according to education level.

		Data obtained from wearable and digital devices (such as smart watches, smart wristbands, digital measurement devices) in remote patient monitoring.					
Level of education		Can be used in certain diseases	Can be used	Cannot be used	Total	Chi-Square	p
High school	n	13	5	3	21	12.42	0.014
	%	61.90%	23.80%	14.30%	100.00%		
Graduate	n	58	54	3	115		
	%	50.40%	47.00%	2.60%	100.00%		
postgraduate	n	20	10	5	35		
	%	57.10%	28.60%	14.30%	100.00%		
Total	n	91	69	11	171		
	%	53.20%	40.40%	6.40%	100.00%		

In Table 5, according to the age groups of the participants, the desire of "wanting to regularly record and follow up your measurements related to your health such as weight, blood pressure, blood sugar, oxygen level" are given. According to the results of the Chi-square test, it was found that the answer given to this question differed statistically significantly according to age groups ($p < 0.01$). According to Table 5, as age increases, the desire to regularly record and monitor measurements such as weight, blood pressure, blood sugar, and oxygen level increases.

Table 5. Comparison of the desire for regular recording and monitoring of measurements such as weight, blood pressure, blood sugar, oxygen level by age groups

Would you like to regularly record and monitor your health-related measurements such as weight, blood pressure, blood sugar, oxygen level?						
Age groups		**Yes**	**No**	**Total**	**Chi-Square**	**p**
18-25 years	**n**	46	43	89	9.592	0.008
	%	51.70%	48.30%	100.00%		
26-33 years	**n**	40	15	55		
	%	72.70%	27.30%	100.00%		
34 years and above	**n**	21	6	27		
	%	77.80%	22.20%	100.00%		
Total	**n**	107	64	171		
	%	62.60%	37.40%	100.00%		

DISCUSSION

The increase in the healthy life expectancy of individuals and the increase in their level of consciousness about healthy life have also led to an increase in the demand for wearable technology products. However, there are various obstacles to the use of these technologies. These obstacles include concerns about data privacy, accuracy and reliability, cost of new technology, lack of wireless or spotty phone-network coverage impairs access, etc. (Carey, Klotz, & Kenny, 2015; Piwek, Ellis, Andrews, Joinson, 2016). In this study, the usage levels of wearable technologies, the perception of individuals and healthcare professionals about these technologies were examined.

According to the results of our study, the rate of using wearable devices was found to be low. It has been found that the use of traditional digital devices is more common than wearable devices. Only 9% of the respondents stated that they used smart watches and smart wristbands. The rate of using smart phones for tracking health indicators was at the level of 65%. The use of traditional digital blood pressure device was found to be 20%. According to a study conducted in China with 2,058 participants by Wen, Zhang, & Lei, (2017), 52.4% of participants reported that they used a wearable device and 94.7% of participants had one year of smart phone experience. However, the results of Tran, Riveros, and Ravaud (2019) are in line with our study. In the study of Tran, Riveros, and Ravaud (2019), there were 1,183 participants in the year of 2018 and only 5% of them reported that they used wearable devices. Schall, Sesek, and Cavuto (2018) also reported that 50.5% of 952 safety engineers used at least one weareble device. A consumer survey was applied to evaluate the current situation regarding wearable technology in the USA (PWC Health Research Institute 2014). According to the results of the research; 21% of participants stated that they had wearable devices. Also, most consumers did not want to spend much on wearables; rather they preferred to be paid to use these tools. 68% of the consumers reported that they would use the wearable technology provided from outside (PWC Health Research Institute 2014). Graham (2014) also indicated that the most common reasons for the participants not to monitor their health status were the lack of interest at 27.2% and the high cost at 17.7%. We found nearly similar results in our study.

Another result of our study is about the question of how the participants recorded measurements related to their health such as weight, blood pressure, blood sugar, oxygen level. A great majority of the participants (80.6%) answered “I do not record and follow up, I take instant measurements”. 15% of the participants stated that they recorded it on their smart phones, while 3.9% stated that they recorded it by noting them manually. Graham (2014), in his research with 900 participants in the USA, asked the participants whether they recorded their weight, diet and exercise programs. 25.1% of the participants in the study stated whether they used a fitness tracker or smartphone application, and 74.9% stated that they did not use or record these tools. When asked whether the participants who did not follow their health status or fitness practices, wanted a fitness recorder provided by the physician, it was revealed that 48.2% wanted it (Graham, 2014). In our study, 66.3% of the participants stated that they wanted to regularly record and follow health-related measurements such as weight, blood pressure, blood sugar, and oxygen level. According to study of Wen, Zhang, & Lei, (2017), the respondents were most interested in heart health monitoring. In their study, the order of health monitoring functions made by the respondents as follows: heart rate monitoring, ECG monitoring, oxygen saturation monitoring, professional sports recording, daily pedometer, body temperature analysis, blood glucose monitoring, and healthy lifestyle reminder (Wen, Zhang, & Lei, 2017). In our study, as

the participants' age increases, the desire to regularly record and monitor measurements such as weight, blood pressure, blood sugar, and oxygen level increases ($p < 0.05$). A study by Wu, Wu, and Chang (2016) showed also age difference in the use of wearable devices. In particular, those below 35 years of age tend to use their smartwatches to show off. Those above 34 years of age were able to truly enjoy the smartwatches they bought for themselves.

In our study, while 56% of the participants stated that they could recommend and use online examination and follow-up facilities for basic health problems or some chronic diseases, 34% were undecided on this issue. 45% of the participants stated that the data obtained from wearable and digital devices could be used for remote patient follow-up, and 50% for the follow-up of certain diseases. Similarly, Tran, Riveros, and Ravaud (2019) stated that 61% of participants thought that wearable health devices would improve the follow-up of patients with chronic illnesses. In our study, 16% of the healthcare personnel did not recommend online examination and follow-up opportunities for basic health problems or some chronic diseases, while 7% of other participants did not. Jacomet et al. (2020) analyzed the perceived of eHealth implementation among people with HIV and their physicians. They found three groups based on perception of physicians on eHealth implementation. First group of physicians (95/219, 43.4%) were "strongly confident in eHealth", who were eager to use and accept these technologies for diagnosis and treatment. Second group of physicians (80/219, 36.5%) were "strongly opposed to eHealth", who were against the collection of personal health data due to confidential problems of eHealth. Third group of physicians (44/219, 20.1%) were "open to eHealth", who thought that eHealth apps were useful for patient education and information. In our study, 65% of the healthcare personnel recommended traditional digital devices to their clients for tracking their health status. 36.5% recommended smart watches, 28.5% suggested smart wristbands and 24.8% recommended biosensors. 82.5% of the healthcare professionals stated that the heart rate data were the most reliable data among the data obtained from traditional digital devices and wearable technological devices. In addition, they found the oxygen data obtained from these devices as reliable by 54%, blood pressure data by 48%, blood glucose data by 44% and ECG data by 34%. Previous studies also have shown that the use of the data obtained from these devices in the diagnosis and treatment of patients will definitely contribute to health services (e.g. Jacomet et al.2020; Tran, Riveros, and Ravaud, 2019). However, there is still ongoing research on the accuracy of data obtained from wearable technologies.

CONCLUSION

Although it has been shown in our study that wearable technologies are mostly accurate and can have clinical use, they are not used enough in the healthcare sector today. Including smart wearable sensors in the routine care of patients can increase physician-patient relationships and increase patient participation in healthcare. With new remote monitoring techniques that will revolutionize health management and spending, these technologies can be used more. In our study, we presented examples from the existing literature in order to evaluate the reliability of wearable devices in monitoring health, and we discussed the level of knowledge and perception of the individuals and healthcare professionals on this issue with the survey study we conducted. These technologies do not currently have widespread use in the public health sector in Turkey. In addition, it is not known how healthcare workers will access data obtained from patients for now. For this reason, it is not possible to evaluate the effectiveness of these devices in public hospitals. However, demands can be determined by conducting research into what the health system, stakeholders and patients expect in this area. In addition, it is recommended to reveal studies on the knowledge levels, perceptions and attitudes of physicians and patients about wearable devices.

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