



Perceptions of Turkish health professional students toward the effects of the internet of things (IOT) technology in the future

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ABSTRACT

Aim: The aim of this study is to determine the perceptions of Turkish health professional students toward the effects of IoT technology.

Background: The twenty-first century has a potential for social, cultural, economic and even political changes due to technological developments. Students should be aware of new technological trends that will influence their profession in the future to be ready for them.

Design: A descriptive and cross-sectional study.

Settings: At two well-established universities (a public and a private university) in a metropolitan city in Turkey with a total of 473 students.

Methods: The study was carried out using an information form and a foresight questionnaire for IoT developed by the researchers. The data were analyzed using parametric tests with SPSS.

Results: Of the participants, 70.8% were female, 81.6% were studying at a public university, 61.3% were senior nursing students, and 38.7% were senior medical students. A majority of the students stated that the IoT technology will affect future medical and nursing practices. The nursing students obtained the highest mean score on the item “Basic physical measurements such as blood sugar, heart rate and ECGs will be easier using IoT technology” (7.36 ± 2.27), and the lowest mean score (5.36 ± 2.82) on the item “Robot physicians and nurses developed through IoT technology will provide patient healthcare in the future”. The nursing and medical students' opinions regarding the future of IoT technology focused on the issues such as smart vital follow-up of patients, mobile health, patient data security, biomedical applications, wearable technologies, and nursing practices in chronic diseases and home care.

Conclusions: The results of this study indicated that IoT technology should be involved in nursing and medical education, and further studies should be conducted to integrate technological trends into healthcare and nursing practices.

Implications for Nursing Practice and Health Policies: The future of IoT technology will focus on subjects such as vital follow-up of patients, monitoring patients with wearable technologies, and nursing practices in chronic diseases and home care. Competency in IoT technology should be included as a requirement in healthcare faculties' professional development policies and programs.

1. Introduction

Broad scientific and technological changes have rapidly influenced in our daily lives in today's communication and information world. These changes lead to the inevitable efforts for individual, organizational, professional and social adaptation. The twenty-first century has a potential for social, cultural, economic and even political changes due to technological developments. Technological developments and

network connections will promote the engagement of patients to learn more about their health conditions and actively participate in health management. These changes will cause a major transformation in the healthcare sector as well, creating a transition from a physician- and hospital-oriented system to an individual-oriented system (Xu et al., 2018; Li et al., 2018; Yang et al., 2018b). Biotechnology, nanotechnology, robotic studies, the internet of things (IoT) and the developments in health informatics are predicted to be the determinants for

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healthcare systems in the future. Nurses and physicians as part of a multidisciplinary team should be basic part of the healthcare technology. With an awareness of the clinical benefits of IoT technology, health professionals will seek innovative approaches for the delivery of healthcare services in the future (Burmaoglu et al., 2017; Mieronkoski et al., 2017; Farahani et al., 2018). They will coordinate, manage and use IoT technology to increase the quality of life for patient-citizens. Nursing and medical students, who are the health professionals of the future, can also adapt to emerging technologies and benefit from IoT technology by being able to use them.

1.1. Background

IoT means the transformation of conventional objects into smart ones using basic technologies such as embedded devices, chips and sensors, communication protocols, sensor networks, and internet protocols and applications. IoT provides each physical object/device with the opportunity to see and hear the others and come together to “talk” so that they can share their knowledge and make decisions (Miorandi et al., 2012; Gubbi et al., 2013; Islam et al., 2015; Aktas et al., 2016; Qi et al., 2017; Li et al., 2018; Xu et al., 2018; Yang et al., 2018b). IoT can be regarded as a worldwide machine-to-machine communication network connecting everything, at all times, and everywhere.

1.2. The Use of IoT in Health Services

The IoT technology system causes healthcare to evolve from the conventional hub-based system to more personalized healthcare systems (PHS). Cost efficiency, reliability and safety are the goals of IoT technology applications in the e-healthcare sector. The IoT-based systems used in healthcare services include mobile-centered healthcare system, smart healthcare services, smart medical sensors, wearable devices, protective systems, remote patient follow-up, diagnosis and monitoring systems (Rowley, 2003; Leyshon et al., 2014; Fan et al., 2014; Islam et al., 2015; Aktas et al., 2016; TUSIAD, 2016; Burmaoglu et al., 2017; Ray, 2017; World Economic Forum, 2018). A report published by the Institute of Medicine (IOM) in 2010 emphasizes that physicians and nurses should have innovative approaches to provide healthcare services through electronic health system, connected home devices, mobile applications, tele-medicine, internet of things (IoT), and artificial intelligence in the future. Futurists and international health organization leaders forecast that healthcare professionals will have new responsibilities in the fields such as smart health technology, remote monitoring, and biomedical devices, and they will be able to reflect these technological developments on their professional activities (Loveridge, 2009; Valiga, 2012; Doyle et al., 2013; Bodur and Kaya, 2017; Shellenbarger and Robb, 2015; OECD, 2016; World Economic Forum, 2016; Archibald and Barnard, 2017). Integrated medical information systems are becoming an essential part of the modern healthcare systems. These systems are considered to be the type of information systems that address the healthcare sector's needs. Prominent studies of IoT technology in healthcare systems are ongoing, and include connected home devices, biomedical applications, sensor technology, monitoring, and smart and remote healthcare systems (Li et al., 2012; Yin et al., 2012; Li et al., 2013; Xu et al., 2014; Fan et al., 2014; Yang et al., 2014; Yan et al., 2015; Islam et al., 2015; Fu and Li, 2016; Yang et al., 2018a; Yang et al., 2018b; Li et al., 2018). Fan et al. (2014) found that the rehabilitation solutions generated by smart rehabilitation systems are similar to those of doctors, and are effective and practicable. Their paper presented an ontology-based automating design methodology for smart rehabilitation systems using IoT technology. The preliminary test results show that the system is both effective and efficient. Fu and Li (2016) conducted a study of keeping electronic medical records of physiological data received from sensors located on distant patients using IoT technology. A decision support method was developed to capture the classification patterns from the

doctor, to establish a new global classification schema and to classify the new patient cases into facet categories. Li et al. (2013) developed a continuous biomedical signal acquisition system that explores a sparsification model for determining the sparse representation of biomedical signals. Biomedical signal acquisition systems are able to measure a subject's blood pressure, blood oxygenation, do electrocardiograms (ECG), electromyography (EMG), and so on. They emphasized that IoT technology can be used in biomedical and patient monitoring applications (Yin et al., 2012). Xu et al. (2014) presented an IoT-based system for emergency medical services to demonstrate how to collect, integrate and interoperate IoT data flexibly in order to provide support to emergency medical services. They concluded that the resource-based IoT data accessing method is effective and IoT is useful in data-intensive industrial applications such as medical services because it provides a platform for accessing large-scale data sources in the mobile application environment. In emergency medical services, the data of patients, doctors, nurses, and ambulances can be collected by IoT notes and transferred to a cloud computing platform. Yang et al. (2014) presented an IoT-based intelligent home-centric healthcare platform that seamlessly connects smart biosensors attached to human bodies for physiological monitoring and intelligent pharmaceutical packaging for daily medication management. They developed a new approach to monitoring the home care of elderly patients. Thus, recent studies have developed a variety of prototypes for reduce the costs of healthcare services by increasing remote patient monitoring and have highlighted the importance of patient engagement and personalized healthcare platforms.

No doubt that applications such as mobile technologies for monitoring vital signs (blood sugar implants, biosensors) and electronic recording systems will introduce new roles for physicians and nurses (IOM, 2010; Valiga, 2012; Grossman and Valiga, 2013; TUSIAD, 2016; Bodur and Kaya, 2017; Mieronkoski et al., 2017; Archibald and Barnard, 2017; World Economic Forum, 2018). IoT-assisted devices are expected to provide support with monitoring patients, tracking human movements, and helping in emergencies (Broadbent et al., 2009; Aktas et al., 2016; Mieronkoski et al., 2017). It is forecasted that vital indicators will be collected using IoT system, which allow for interactive patient follow-up together with the healthcare personnel. Hospital occupancy and whether patients leave their beds can be monitored using smart bed systems. Thus, nurses and physicians can monitor and follow-up their patients through web-based technologies, which provides a timelier, easier, safer, and more frequent monitoring. In addition, IoT technology can also be applied to home medication management, for example home drug delivery systems, in order to monitor whether patients have taken their medication and, if necessary, alert care providers (Islam et al., 2015).

Based on this information, future health professionals' opinions regarding the effects of IoT technology on the future of healthcare systems are very important in terms of their readiness for the technological developments. No studies have been found to analyze the opinions of nursing and medical students regarding the effects of IoT technology on the future of healthcare systems.

1.3. Aim of Study

This study aims to find out the future health professionals' opinions regarding the future trends in health and technology, to determine whether they are ready to use new health technologies and to identify the use of IoT technology in medical applications.

2. Methods

2.1. Design

This is a descriptive and cross-sectional study.

2.2. Setting and Sample

The study population consisted of senior nursing and medical students registered at two well-established universities (a public and a private university) in Istanbul, Turkey (N: 473) in the 2016–2017 academic year. Turkey is a country with a young population, of whom 16.1% are young people in the 15–24 age group. The number of young people across the country reached 12,983,97 people, of whom 51.2% were young men, and 48.8% were young women (TUİK, 2018). The selected medical and nursing faculties are well-established with a brand value and have a high student population, as well as two large-scale hospitals. Since both faculties are located in a cosmopolitan city, Istanbul, and receive students from all regions of Turkey, this study sample represents Turkish students in general.

The study sample was selected using disproportionate cluster sampling, and all of the registered senior students were included in the study. The selection criteria for the institutions were: (1) being an education and research university, (2) having a hospital affiliated to the university for training and research activities, and (3) being outstanding and well-established educational institutions in Turkey. Senior nursing and medical faculty students have studied for at least four years. Both of the student groups have at least four years of clinical experience in different areas of hospitals. Since senior students conduct professional initiatives and develop their future orientation, senior students were included in the study sample. Power analysis was performed to determine the sample size and power. The minimum number of students to be included in the study sample was found to be 335 (127 medical faculty students and 208 nursing faculty students) in bilateral correlation with a type 1 mistake rate of (α) = 0.05 and a 95% confidence interval. The study sample included 473 students, which was more than the required number of students and boosted the power of the study.

2.3. Data Collection

The data were collected using an information form with 10 questions and a foresight questionnaire for IoT with 9 questions, which were developed by the researchers after a literature review to identify students' demographic characteristics and opinions regarding the effects of IoT technology on the future of healthcare systems.

2.3.1. Information Form

This form included 10 questions about the participants' socio-demographic characteristics (age, department, gender, education level, knowledge about IoT technology, following the publications on IoT technology, opinions on the fields that IoT technology will affect and where IoT technology can be used, opinions regarding the effects of IoT technology on future medical and nursing practices) (Aktas et al., 2016; Mieronkoski et al., 2017; Bodur and Kaya, 2017).

2.3.2. The Foresight Questionnaire for IoT

This questionnaire included items regarding the effects of IoT technology on healthcare systems (Gubbi et al., 2013; Gore, 2013; Islam et al., 2015; Mieronkoski et al., 2017; Bodur and Kaya, 2017). Since there are no valid and reliable instruments for determining students' views of IoT, the questions were created by the researchers after a review of the literature, and psychometric analyses were not conducted. The participants were asked to score each item between 0 (I disagree) and 10 (I strongly agree). One of the researchers outlined the details of the study to all nursing students in the class. The delivery and completion of the questionnaires took 15 min on average. The students returned the complete or incomplete questionnaires to the researchers before leaving the class.

2.4. Ethical Considerations

The data were collected from voluntary students in the spring semester of the 2016–2017 academic year, after obtaining the required permissions from the public and private university hospitals and the approval of the relevant institutions and the Social Sciences Research Ethics Committee of a university hospital (approval date and number: 1.19.2017, 2016.278.IRB3.135). The participants were verbally informed about the definition of IoT technology and the study aims, and each student received a sheet indicating the study aim, the researchers and methodology. Then, the questionnaire form and the scales were distributed to voluntary nursing students. No personally identifiable information was requested. The students were not forced to complete the forms during data collection.

2.5. Data Analysis

The data were entered and analyzed using frequencies, percentages, means and standard deviations with the SPSS (Statistical Package for the Social Sciences) software, version 21.0 (SPSS Inc).

3. Results

3.1. Defining Characteristics of the Students

The mean age of the participants was 22.53 years. Of them, 70.8% were female, 29.2% were male, 81.6% were studying at a public university, and 18.4% were studying at a private university. Of them, 61.3% were senior nursing students, and 38.7% were senior medical students.

3.2. The Students' Knowledge Levels on the Future of IoT Technology

Of the medical students at the private university, 68.0% had no knowledge about IoT technology, and 84.0% did not follow the publications on IoT technology (Table 1). In addition, all the students indicated that IoT technology will have the highest influence on the health and education sectors. A majority of the students in both groups stated that IoT technology can be most commonly used in smart patient follow-ups and mobile health applications. However, most of the nursing students at the private university indicated that IoT technology can be most commonly used in patient data security, web-based applications, and smart cities and hospitals (Table 1). A majority of both the private university nursing and the public university medical students stated that IoT technology will affect future medical and nursing practices. However, half of the public university medical and nursing students reported that they had no information about the effects of IoT technology on future nursing practices.

3.3. The Nursing Students' Opinions on the Future of IoT Technology

The nursing students obtained the highest scores on the item “Basic physical measurements such as blood sugar, heart rate and ECGs will be easier using IoT technology,” followed by the items “IoT technology will facilitate patient follow-up by allowing a rapid communication between physicians, nurses and patient relatives,” “Hospitalization times will be shortened and home care services will become more common through IoT technology,” “The provision of remote care services through IoT technology will reduce workload in health services,” “Chronic diseases can be monitored and measured remotely using IoT technology,” and “Physiological data can be collected from patients using wearable and implantable sensors to be developed by IoT technology,” respectively. They obtained the lowest mean score (5.36 ± 2.82) on the item “Robot physicians and nurses developed through IoT technology will provide patient healthcare in the future” (Table 2).

Table 1
The levels of nursing and medical school students' knowledge of the future of IoT technology (N: 473).

Items		Nursing faculty				Medical faculty			
		Private U. (n: 74)		Public U. (n: 216)		Private U. (n: 100)		Public U. (n: 83)	
		n	%	n	%	n	%	n	%
Knowing about IoT technology	Yes, I do	28	37.8	77	35.6	32	32.0	41	49.4
	No, I do not	46	62.2	139	64.4	68	68.0	42	50.6
Following publications on IoT technology	Yes, I do	2	2.7	28	13.0	16	16.0	7	8.4
	No, I do not	72	97.3	188	87.0	84	84.0	76	91.6
Will IoT technology affect future medical applications?	Yes, it will	52	70.3	101	46.8	52	52.0	60	72.3
	No, it will not	0	0	7	3.2	2	2.0	0	0
	I have no information	22	29.7	108	50.0	46	46.0	23	27.7
Will IoT technology affect future nursing applications?	Yes, it will	44	59.5	96	44.4	46	46.0	36	43.4
	No, it will not	6	8.1	6	2.8	2	2.0	4	4.8
	I have no information	24	32.4	114	52.8	52	52.0	43	51.8
Fields to be most affected by IoT technology ^a	Health	66	89.2	158	73.1	68	68.0	71	85.5
	Education	62	83.8	154	71.3	58	58.0	69	83.1
	Industry	46	62.2	79	36.6	44	44.0	47	56.6
	Energy	44	59.5	73	33.8	44	44.0	48	57.8
	Genetics	54	73.0	78	36.1	42	42.0	54	65.1
	Environment	50	67.6	92	42.6	52	52.0	49	59.0
	Psychology	42	56.8	79	36.6	42	42.0	39	47.0
	Data security	50	67.6	81	37.5	50	50.0	51	61.4
	I have no information	6	8.1	38	17.6	34	34.0	11	13.2
	Fields where IoT technology can be used most ^a	Smart patient follow-ups	58	78.4	139	64.4	68	68.0	68
Mobile health applications		58	78.4	122	56.5	66	66.0	59	71.1
Patient data security		56	75.7	102	47.2	56	56.0	57	68.7
Nanotechnology		38	51.4	92	42.6	52	52.0	46	55.4
Web based health and care services		52	70.3	91	42.1	52	52.0	54	65.1
Biomedical applications		50	67.6	107	49.5	54	54.0	58	69.9
Smart cities and hospitals		52	70.3	93	43.1	48	48.0	56	67.5
Wearable technologies		44	59.5	94	43.5	52	52.0	48	57.8
I have no information		8	10.8	45	20.9	30	32.0	10	12.0

^a More than one option was marked.

3.4. The Medical School Students' Opinions on the Future of IoT Technology

The medical students obtained the highest scores on the item “Basic physical measurements such as blood sugar, heart rate, and ECG will be easier through IoT technology,” followed by the items “Physiological data can be collected from patients using wearable and implantable

sensors to be developed by IoT technology,” “Chronic diseases can be monitored and measured remotely using IoT technology,” and “IoT technology will facilitate patient follow-up by allowing a rapid communication between physicians, nurses and patient relatives,” respectively. The medical students obtained the lowest mean score (4.43 ± 3.27) on the item “Robot physicians and nurses developed

Table 2
The views of the nursing and medical school students about the future of IoT technology (N: 473).

Items	Nursing faculty			Medical faculty		
	Private U. (n: 74)	Public U. (n:216)	Total X ± SD	Private U. (n: 100)	Public U. (n: 83)	Total X ± SD
	Mode (n, %) X ± SS	Mode (n, %) X ± SS		Mode (n, %) X ± SS	Mode (n, %) X ± SS	
Chronic diseases can be monitored and measured remotely using IoT technology.	8 (18, 23.1%) 7.08 ± 2.39	5 (53, 24.5%) 6.69 ± 2.23	6.79 ± 2.27	10 (30, 30.0%) 7.24 ± 2.98	10 (17, 20.5%) 7.09 ± 2.40	7.17 ± 2.73
Physiological data can be collected from patients using wearable and implantable sensors to be developed by IoT technology.	10 (16, 21.6%) 7.37 ± 2.08	5 (48, 22.2%) 6.56 ± 2.30	6.77 ± 2.27	10 (28, 28.0%) 7.24 ± 2.90	10 (22, 26.5%) 7.87 ± 2.26	7.53 ± 2.64
The provision of remote care services through IoT technology will reduce workload in health services.	9 (18, 24.3%) 7.29 ± 2.07	5 (39, 18.1%) 6.89 ± 2.55	6.88 ± 2.38	10 (20, 20.0%) 5.92 ± 3.26	8 (21, 25.3%) 7.24 ± 2.55	6.51 ± 3.02
Hospitalization times will be shortened and home care services will increase through IoT technology.	9 (16, 21.6%) 7.16 ± 2.29	5 (53, 24.5%) 6.90 ± 2.03	6.97 ± 2.10	7 (20, 20.0%) 5.82 ± 3.11	7 (17, 20.5%) 6.68 ± 2.90	6.21 ± 3.04
Basic physical measurements such as blood sugar, heart rate, and ECGs will be easier to do using IoT technology.	10 (20, 27.0%) 7.83 ± 2.20	10 (42, 19.4%) 7.19 ± 2.28	7.36 ± 2.27	10 (28, 28.0%) 7.46 ± 2.92	8 (19, 22.9%) 7.65 ± 2.41	7.54 ± 2.69
IoT technology will facilitate patient follow-up enabling rapid communication between physicians, nurses and patient relatives.	8 (18, 24.3%) 7.29 ± 2.07	5 (38, 17.6%) 6.89 ± 2.55	7.00 ± 2.44	7 (22, 22.0%) 6.74 ± 2.94	7 (20, 24.1%) 7.31 ± 2.65	7.00 ± 2.82
Robot physicians and nurses developed through IoT technology will provide patient health care in the future.	6 (10, 13.5%) 4.86 ± 3.15	5 (55, 25.5%) 5.54 ± 2.68	5.36 ± 2.82	2 (16, 16.0%) 4.72 ± 3.27	2 (25, 30.1%) 4.09 ± 3.13	4.43 ± 3.27
The cost of future health care services will decrease due to IoT technology.	5 (18, 24.3%) 6.32 ± 2.51	5 (57, 26.4%) 5.78 ± 2.49	5.92 ± 2.50	8 (18, 18.0%) 5.38 ± 3.01	6 (18, 21.7%) 6.02 ± 3.10	5.67 ± 3.06
Remote patient diagnosis and treatment services will become widespread through IoT technology.	5 (16, 21.6%) 6.43 ± 2.19	5 (46, 21.3%) 6.47 ± 2.15	6.46 ± 2.16	5 (18, 18.0%) 5.90 ± 3.10	8 (15, 18.1%) 5.61 ± 3.16	5.77 ± 3.12

through IoT technology will provide patient healthcare in the future”.

4. Discussion

Most of the students had no knowledge on IoT and did not follow publications regarding the IoT technologies, which are new and rapidly developing (European Union, 2010; Future Health Index, 2016; Aktas et al., 2016; World Economic Forum, 2018). Many applications can be used interchangeably or together thanks to the developments and diversification in healthcare applications. The concepts of mobile health, artificial intelligence and biotechnology are discussed together with the IoT technology. The students' lack of knowledge can be considered normal because of the new and complicated nature of these applications.

The majority of the participants from both departments stated that the IoT technology will affect health, education, genetic and data security and will directly affect medical and nursing practices in particular, and that IoT technology can be most commonly used in smart patient follow-ups and mobile health applications. In addition, the public university nursing and medical students stated that IoT technology will be used in biomedical applications. Previous studies have reported that IoT technologies will directly affect the future healthcare practices in the fields of home care, chronic diseases, patient monitoring systems and geriatric care (IOM, 2010; National Intelligence Council, 2012; Turkish Futurism Association, 2015; Schartinger et al., 2015; TUSIAD, 2016; Mieronkoski et al., 2017; Bodur and Kaya, 2017; Bodur and Aydoğan, 2017). This finding suggests that, although the students did not adequately follow the developments in health informatics, their opinions were consistent with the literature. This is a promising result in terms of the students' readiness for the future.

The nursing students' opinions regarding the future of IoT technology focused on the issues such as vital follow-up (blood glucose, ECG, etc.) of patients, monitoring the patients with wearable technologies, and nursing practices in chronic diseases and home care. Studies emphasize that many innovations will directly influence the future of nursing through smart and wearable sensors developed as part of healthcare applications, clothes that can measure vital signs, blood sugar implants, skin surface biosensors that can measure vital signs, easy-to-use portable medical devices, and biotechnology (Valiga, 2012; Leyshon et al., 2014; Yang et al., 2014; Mieronkoski et al., 2017; Ali et al., 2015; Islam et al., 2015; Bodur and Aydoğan, 2017; Archibald and Barnard, 2017). As the mobile health systems becomes more common, developments are expected in patient monitoring systems. Nurses and physicians will be able to monitor patients remotely and initiate basic interventions in emergencies. In this way, vital follow-ups with IoT technology will help nurses and other health professionals to ensure patient safety, and easily and rapidly provide healthcare services. It will also help to reduce medical errors. The results of this study showed that the nursing students thought that IoT technology will affect the future of nursing practices. This result suggests that nursing students are aware of the technologies that will influence their profession in the future and are ready for new technological trends. Their main opinions were consistent with the relevant literature and futurists' predictions (Loveridge, 2009; European Union, 2010; Turkish Futurism Association, 2015; OECD, 2016; World Economic Forum, 2016; Bodur and Kaya, 2017; Li et al., 2018). The nursing students at the private university obtained higher mean scores on all items than the nursing students at the public university. They obtained the highest mean score on the item “Physiological data can be collected from patients using wearable and implantable sensors to be developed by IoT technology,” which suggests that students at private universities may have more opportunities to acquire information about the applications related to health informatics due to their larger economic and hardware facilities.

The medical students' opinions regarding the future of IoT technology focused on the issues such as vital follow-up (blood glucose, ECG, etc.) of patients, wearable technology, chronic diseases.

Increasing aging populations and chronic diseases change patient needs. Patients need to be at the center of digital transformation of health and care. Healthcare organizations are going to transform patient-centered care. Home care services will increase in the future. With increasing home care services, IoT technology will catalyze patient follow-up (Islam et al., 2015; Mieronkoski et al., 2017; Qi et al., 2017; Farahani et al., 2018; World Economic Forum, 2018). Digital health can enable care to be structured around people's needs and preferences, improve the coordination of care and lead to more effective exchange of information between healthcare professionals and patients. Therefore, provision of health services outside hospitals using wireless technologies has become inevitable. Increasing populations with illness limit physicians' ability to check each patient with quality time. Likewise, with the high number of patient population and elderly population, patient care, follow-up and medication applications take up a lot of time for health professionals. Providing remote care service using wireless technology will reduce the workloads of healthcare providers (Schartinger et al., 2015; Farahani et al., 2018). In addition, long-term treatment in hospitals may cause physical, psychological and social problems. Physiological vital data will be collected by patients to reduce these problems with the emerging wireless technologies (Miorandi et al., 2012; Schartinger et al., 2015; Islam et al., 2015; Aktas et al., 2016; Ahmed and Ali, 2016; Burmaoglu et al., 2017; Bodur and Aydoğan, 2017). In addition, futurists and the relevant studies emphasize that disorders such as heart diseases, cancer, depression and obesity will increase due to the increased elderly population, and therefore the disease- and treatment-oriented applications will be replaced by individual-oriented, preventive, remote and integrated monitoring and care applications (Saritas and Smith, 2011; Valiga, 2012; Gore, 2013; Grossman and Valiga, 2013; Schartinger et al., 2015; TUSIAD, 2016; World Economic Forum, 2018). This suggests that the medical faculty students have predicted the changes that will be observed in healthcare systems in the future and have a potential for benefiting from the predicted developments.

Both the medical and nursing students obtained the lowest mean score (4.09 ± 3.13) on the item “Robot physicians and nurses developed through IoT technology will provide patient healthcare in the future.” Futurists emphasize that IoT-assisted robotic applications, robotic nurses, digital and smart hospitals are some innovative opportunities that will influence healthcare systems. Studies report that IoT-assisted robots can help monitor patients, support patients with motor problems in daily life activities, carry and distribute medicines and supplies automatically, assist staff with various tasks, track human movements, and help in emergencies. IoT-assisted applications include smart objects and robots, portable medical devices that measuring blood pressure constantly, SMS reports of individuals' vital signs to healthcare staff and fall monitors for the elderly using wall-mounted sensors and warning care centers (European Union, 2010; Miorandi et al., 2012; Gubbi et al., 2013; Leyshon et al., 2014; Aktas et al., 2016; TUSIAD, 2016; Bodur and Aydoğan, 2017; Archibald and Barnard, 2017). Many of these applications have been already put into practice, and further applications will begin to be used soon. Today, robotic studies are expected to become widespread due to the increased use of IoT, artificial intelligence and biotechnology. Studies of robotic applications are new, and the number of descriptive and social studies is very limited in this field. Although it is a rapidly developing field, IoT technologies and robotics studies do not have the expected impact in Turkey yet. This suggests that nursing and medical school students are not aware of the effects of robots on future healthcare systems or they cannot imagine robotic health professionals.

4.1. Limitations

This study was limited to the senior medical and nursing students at two universities in Istanbul, Turkey between January 2017 and May 2017. Since no valid and reliable instrument was found to determine

the students' opinions on IoT, the questionnaires were developed by the researchers after a literature review, and psychometric analyses were not conducted. Therefore, the results were presented through the mean scores on the items.

5. Conclusion

The results of this study suggest that students are aware of the dynamics that will affect the world, health, medicine and nursing in the future, and can forecast the changes that may occur in the future, but do not have adequate knowledge on IoT technologies and applications. However, they are ready to take advantage of the technological changes that will affect healthcare systems.

In conclusion, IoT technology is a new, diverse and uncertain field that is open for exploration. IoT-enabled healthcare is highly interdisciplinary, involving methodologies from computer science, engineering, information science, behavioral science, as well as many applied areas in medicine, nursing and public health. The IoT technology will have an influence on the medical and nursing practices as a result of the rapid changes in demographic structure, healthcare systems and technology in the twenty-first century. Future studies will need to focus on new informatics methods in each layer of the IoT ecosystem, seeking ways to empower successfully the utility of IoT-enabled technology in healthcare. These results indicated that IoT technology and informatics should be involved in nursing education and further studies should be conducted to integrate technological trends into healthcare and nursing practices.

Author Contributions

Study design: GB.
 Data collection: GB, SG, NGG.
 Data analysis: GB, SG, NGG.
 Study supervision: GB.
 Drafting of manuscript: GB, SG, NGG.
 Critical revisions for important intellectual content: GB.

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Conflict of Interest

None.

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