

Table S1. Main Characteristics and Description of the IoT Used in the Studies

First Author	Year	Aim of Study	Study Type	Technologies Used in IoT	Medical Field	Application of IoT in Health	Results
Souri (20)	2020	Providing a student healthcare monitoring model based on the IoT	Applied study	In the form of sensors in smart wearable clothes and smart bracelets	General health	Monitoring and care, continuous monitoring of vital signs, and detection of biological and behavioral changes	The proposed model works well. Compared to other models, it has a significant difference in real-time health performance status for students.
Kazemi (21)	2018	Providing an IoT-based, dedicated hardware threat assessment platform for microcontroller unit-connected device software developers to assess their system's robustness against hardware-based threats	Applied study	The use of applications to control automatic drug infusion pumps connected to the Internet that automatically injects the amount of medicine to a person, and sensors in its structure, sensors in the structure of a smart portable heart pacemaker.	Pharmacology and cardiovascular diseases	Telemonitoring and care and control of automatic drug infusion pumps	The platform proved to be helpful against software and hardware threats and attacks.
Yahyaie (22)	2018	Presenting an IoT-based model for heart attack prediction	Applied study	Sensors in mobile phones	Cardiovascular disease	Telemonitoring and care	The use of IoT, along with cloud computing and data mining techniques, can predict heart attacks with acceptable accuracy.
Prouschi (23)	2017	Examining the application of IoT in the prediction, monitoring, and care of eye diseases	Applied study	The use of sensors and sensors in the structure of smart glasses to detect potentially dangerous eye changes	Ophthalmology	Telemonitoring and care	Glasses designed using IoT technologies can inform patients who are prone to eye stroke, macular degeneration, and other possible diseases and prevent the risk of blindness.
Noori (24)	2020	Presenting a new authentication method based on the elliptic curve. Elliptic curve cryptography for IoT in the healthcare environment.	Applied study	N. A	Blood transformation	Medication management Telemonitoring and care Blood package tracking equipment tracking and locating	In addition to maintaining security, the method proposed in this article has lower computational costs than similar studies, and this method has been successful.
Rahmani (25)	2022	Introducing the complex event processing (CEP) method in the IoT as a new solution to increase reliability, reduce costs, and improve the quality of healthcare	Case study	Biological sensors to send vital signs such as body temperature, electrocardiogram (ECG), and pulse oximetry (SPO ₂ and the like) using a client Android application and a server using Wi-Fi communication, which is responsible for correct data collection.	Patients who need to repeatedly check their vital signs, such as respiration rate (RR), ECG, SPO, and the like	Data and information analysis Quick diagnosis Effective treatment of patients	The IoT with the CEP method has improved the efficiency of treatment and meets the vital needs of patients using predefined rules.

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Yazdani (26)	2021	Providing a conceptual model based on health information technology services for the management of COVID-19 with the help of the IoT	Cross-sectional	The use of medical applications on smart mobile phones to monitor and track the patient and IoT devices such as wearable and environmental sensors and like to collect data about the patient's healthcare.	COVID-19 pandemic	Remote medical consultation and identification of suspicious cases without going to medical centers	Communication and information technology tools, including the IoT, play an important role in all aspects of managing infectious diseases such as COVID-19.
Amintoosi (27)	2022	Introducing an authentication model in the Internet of Medical Things (IoMT) medical IoT system for the security of patients' private information	Applied study	Smart wearable sensors that collect and send information such as heart rate (HR), transmitting information through wireless media	COVID-19 pandemic	Virtual consultation by medical staff and specialists Telemonitoring and care of the patient's health status Diagnosis of a possible disease Transmitting remote medical advice	By using the presented model, the information security of patients can be ensured, and it enables the use of the IoMT.
Mehrabi (28)	2022	Providing a model for the development of Android mobile apps for health monitoring based on the IoT	Case study	Support for Android applications on smartphones and web-based systems to visualize health status as a gateway to transmit health information to healthcare providers using physical objects such as wearable sensors to collect blood pressure (BP) and HR information using devices to record environmental parameters such as humidity and temperature	Chronic and infectious diseases, BP, respiratory disease, and human immunodeficiency virus	Telemonitoring the health of patients	The presentation model is usable and useful for the production of IoT-based Android health monitoring applications.
Abdali-Mohammadi (29)	2020	Presenting a new hybrid decision-making method for diagnosing diseases as well as designing a reliable electronic health monitoring device based on IoT	Applied study	These sensors collect the patient's physiological parameters in a structured and unstructured way and transmit them to a coordinator called a gateway, which is a wearable device or a smartphone. The signal is transmitted to the cloud storage tank using wireless communication media such as 3G/4G mobile networks. Finally, the health-based IoT data of each user is stored in the cloud-based operating system.	Diabetes	Telemonitoring and accessing patient records anywhere and remotely	The results show that the proposed new healthcare plan based on cloud computing and IoT for disease monitoring and diagnosis works better than the current methods and systems for diabetes diagnosis.
Akbarzadeh (30)	2021	Providing a solution for intelligent management of health monitoring services in hospitals in the era of COVID-19 and other future pandemics based on IoT	Applied study	Global positioning system and similar satellite-based models, Bluetooth fingerprinting, ultrawideband, and cellular proximity	COVID-19 pandemic	Identification of patients with COVID-19 Reduction of prevalence Reduction of the impact of the pandemic	The proposed scheme has been successful in managing COVID-19 by integrating several services and applications of IoT technology to create a comprehensive platform with minimal hardware usage and maximum adaptability.
Akhbarifar (31)	2020	Presenting a remote monitoring model to provide medical health	Cross-sectional study	Sensor technology related to wearable medical equipment IoT network and data collection: This section includes network	Chronic kidney disease and heart disease	Telemonitoring and screening of patients' health status anywhere and anytime	In addition to maintaining the confidentiality and security of sensitive medical data, the remote health monitoring model in this study provides an effective development for remote

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		data in a cloud-based IoT environment		devices and sensors for the IoT and resources to measure and collect the biological data of patients. The collected data include the patient's vital signs, such as blood cholesterol, BP, HR, and other biological data, which are sensed by sensors mounted on the patient's clothing or body through the body area network.			medical monitoring to detect any threatening conditions in patients.
Asghari (32)	2019	Providing a medical monitoring plan for a cloud-based IoT platform in disease management	Applied study	Medical devices and wearable sensors equipped with IoT collect physiological data such as HR, temperature, oxygen saturation, respiratory flow rate, and the like, and according to other medical records, the medical conditions of patients are extracted through the prediction of diseases.	Diabetes mellitus, kidney failure, high BP, and cardiac disorders	Telemonitoring Early diagnosis of diseases Prediction of clinical events Recommendation of vital medical health guidelines	The disease diagnosis process and, as a result, appropriate medical recommendations can be performed more effectively in the form of an IoT-based medical monitoring plan.
Farahani (12)	2017	Discussing the application of IoT in healthcare and medicine by presenting a comprehensive architecture of the IoT e-health ecosystem	Case study	Smart glasses for non-stop and continuous HR control and smart gloves; Application in Parkinson's disease	Parkinson, skin diseases, And various chronic diseases	Saving time, cost, and energy for patients to receive clinical services Informing a person about his health condition without spending more time and money on medical examinations	There is an increasing need for clinic-centered and patient-centered healthcare. The IoT is expected to be a powerful enabler by providing seamless connectivity between devices and cloud storage, as well as agents such as patients, hospitals, analytical laboratories, and emergency services.
Firouzi (33)	2018	Analysis of the main concerns in the application of IoT technologies in the healthcare environment	Applied study	Wearable biosensors: Data generated from sensors connected to users is made available to doctors, family, and authorized persons, allowing them to monitor vital signs from anywhere and anytime, as well as make intelligent decisions to help healthcare workers.	General health	Telemonitoring and checking vital signs	As a result, to apply and sustain IoT technologies in medicine, many changes must occur; for example, hardware and software must be engineered and work together to be able to address IoT technologies and their role in healthcare.
Fotouhi (34)	2020	Providing an IoT-based authentication scheme in the healthcare environment	Applied study	Wireless body area network. This technology has made medical equipment work without wires or cables and has made it easier to move such devices.	Alzheimer's	Telemonitoring and checking vital signs	The results demonstrated that the proposed scheme is significantly safer and more efficient for implementation in healthcare environments.
Ghasemi (35)	2019	Providing an architecture for a healthcare system in a smart home based on the IoT	Case study	Wearable and environmental sensors that collect sensor data, including environmental sensors (gas leakage), wearable sensors (vital signs), and accelerometer sensors, are sent to the home server. In the home server section, received data are prioritized based on their importance. Vital signs data and	Diabetes and BP	Elderly healthcare monitoring, including vital signs and falls using environmental sensors, fire occurrences, and gas leaks Telemonitoring and care	This architecture has reduced costs due to the early detection of diseases and accidents by full-time monitoring of the daily activities of the elderly through smart home sensors. Considering the criticality of the elderly healthcare system, the quality features that were observed in the architecture were availability, performance, security, and interoperability.

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Ghorbani (36)	2019	Providing assistive tools based on technologies such as the IoT for the interaction and independence of Alzheimer's patients and their family members.	Applied study	accelerometer sensor data have higher priority for processing. Smart glasses by recognizing the QR code in the environment and receiving information about tags in the form of sound, text, or 3D images on a smartphone, or Windows application	Alzheimer's	Remembering the daily events of a person with Alzheimer's.	In this study, operational testing and evaluation of the system were performed, and the reliability and performance of the ambient assisted living system were presented according to the effective parameters and preliminary test results.
Hamidi (37)	2018	Providing a safe and stable solution based on IoT with the benefit of biometric technology in line with smart healthcare technologies	Applied study	Biometric sensors and wireless sensors: Biometric sensors are used to collect necessary data from users in a smart environment.	General health	Telemonitoring and care	The real development of intelligent healthcare systems requires measures to ensure privacy and customized security levels.
Yazdanpanah (38)	2022	Security monitoring of audio-biomedical signal communications in healthcare and IoT technologies	Applied study	N. A	COVID-19 pandemic	Telemonitoring and checking vital signs	The evaluation results proved that the algorithm works efficiently in detecting Stego files created by Hide4PGP, S-tools4, and Stegowav. The virtual ear is sensitive to changes in the high-frequency region and is based on the reversed Mel scale.
Haghighparast (39)	2020	Providing a security framework with four layers of sensor, network, application, and service in order to provide security solutions in the IoT	Applied study	Middleware technology in order to use software and hardware platforms, and authentication technology using a dynamic Bayesian network in order to increase the security of information exchange.	General health	Telemonitoring and care	Security solutions in the network layer and sub-criteria of authentication and validation help develop the proposed security framework. Considering the importance of this technology in the future, it is possible to improve the health security of the IoT in the network layer based on many communication protocols and algorithms.
Javid (40)	2021	Providing a trusted data transfer protocol in IoT-based healthcare	Applied study	Environmental monitoring sensors and critical message sensors to send information to medical centers	Surgery	Monitoring the patient's vital signs throughout the day, collecting information, and providing it to nursing stations for healthcare services	The proposed method has achieved reliability and data delivery rates, and improved network lifetime, delivery rate, and delay, respectively.
Jamili Oskouei (41)	2020	Providing services and helping Alzheimer's patients	Applied study	Smartwatches to monitor vital signs, wireless sensors, smartphone apps, tags attached to patients' clothing, and smart cameras for identification.	Alzheimer's	The possibility of access to and information about Alzheimer's patients The possibility of tracking the location of the doctor, patient, and ambulance Ability to monitor geographic location	The proposed system is highly accurate in providing emergency alerts and reporting the status of patients.
Firouzi (42)	2020	Presenting several techniques combined with IoT to fight against COVID-19	Applied study	Mobile smart devices, such as smartwatches, to monitor patients	COVID-19 pandemic	Remote tracking and monitoring of patients by wearable devices Personal digital devices Identification of people in contact with an infected person Rapid screening and early detection Warnings to authorities, health workers, and families in emergencies	By using IoT, it is possible to minimize the loss of life in COVID-19.
Bokharaei Nia (43)	2021	Providing a framework based on the IoT for a system that provides the	Applied study	Smart wearable devices to increase self-care and motion	All kinds of diseases, especially heart disease and diabetes	Continuous monitoring of patients, registration of their vital signs, and advice to doctors	Considering the significant impact of IoT on patient monitoring in healthcare environments, it is suggested that

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		best devices needed by the patient		sensors to record a person's movements			manufacturers of smart wearable devices use the results of the proposed platform to develop personalized wearable devices for patients.
Dami (44)	2021	Developing an IoT-based deep learning approach to predict cardiovascular events weeks or months before the event	Applied study	Electroencephalography (EEG) Long-short-term memory neural network (LSTM) in order to avoid long-term dependencies-a deep belief network (DBN) in order to represent and select more efficient and effective features of recorded data sets-wearable heart rate monitoring sensors	Cardiovascular diseases	Recording data to demonstrate and select more efficient practices Controlling and monitoring the condition of patients Telemonitoring mobile healthcare Monitoring HR	The proposed LSTM-DBN (average accuracy of 88.42%) performed better compared to other deep learning approaches and traditional classifications.
Attarian (45)	2021	Designing a protocol for data transfer in order to establish security in m-Health applications based on the IoT	Applied study	M-Health, wearable sensors, elliptic curve cryptography-based ring signatures, and blockchain smart data placement	General health	Telemonitoring Identifying any malicious client using the identity disclosure process easily Providing protection against all types of attacks	The proposed protocol has reasonable computational costs and security protections for IoT-based mHealth transactions.
Honarparvar (46)	2021	Designing and developing an architecture to reduce the occurrence of simple missed events and increase the accuracy of complex event detection with smart cameras.	Applied study	Smart cameras, radio frequencies for recording movements and cough detection, cloud computing technologies, edge computing for privacy issues, deep learning, IoT, and cloud computing technologies	COVID-19 pandemic	Transferring information from different sources automatically to devices Re-identifying people using multiple cameras Managing disasters	With the help of IoT and other technologies, multiple cameras provide better results than single cameras in terms of complex event detection accuracy. The delay in the integrated architecture was greater than that in the edge-based computing architecture, but this did not have a significant impact on the case study of the detection of the risk behavior of COVID-19. This design was fruitful for COVID-19 patients and their diagnosis.
Nasr Esfahani (47)	2021	Providing a privacy plan based on the IoT for patients	Applied study	Blockchain technology that prevents impersonation and provides distributed storage for healthcare, sensors for data collection, and smartphones	General health	Privacy protection against internal threats and external attacks Maintaining the confidentiality of patient information	The proposed protocol has been successful in maintaining patients' privacy.
Nadian-Ghomsheh (48)	2021	Providing a comprehensive range of motion (ROM) evaluation solution based on the IoT	Applied study	Smart cameras, using machine learning techniques, marker-based motion capture to measure, ROM, markerless hand motion recording, and leap motion devices to extract hand joint information through a computer vision approach	Orthopedics	Telerehabilitation Providing patients with treatment exercises for different joints Monitoring patient progress Enabling performance analysis	The proposed method allows the immediate evaluation and extraction of ROM as vital information for analyzing patients' progress.
Asghari (49)	2019	Presenting a colorectal cancer prediction model based on IoT in the elderly	Applied study	Smart wearable devices such as smartwatches to record vital signs and medical IoT devices	Elderly and colorectal cancer	Continuous measurement of biological indicators of the elderly Collection of vital medical data	The proposed model works with reasonable accuracy in predicting colorectal cancer in the elderly.
Ghasemi (50)	2016	Prioritizing IoT applications in Iran's healthcare sector to achieve sustainable development	Cross-sectional study	With radio frequency identification designed to measure pollution, toothbrushes equipped with Bluetooth that record brushing information with the help of smartphone applications.	Chronic diseases, elderly, and dental health	Management of chronic diseases Monitoring of patients Fall detection Pollution control	Controlling the management of chronic diseases by means of IoT technology will reduce many of the department's problems; it will also make monitoring of patients and the work of hospital staff easier and reduce the errors of nurses. In addition, the imagination of patients and their companions, and finally, the control of contamination will be easier. It will be useful for hospitals, treatment centers, and citizens.

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Ronaghi (51)	2018	Examining and identifying services and ranking the importance of IoT technology in healthcare	Cross-sectional study	Wearable and chemical behavioral sensors and sensors used in remote patient care systems, emergency alert systems, fitness programs, chronic disease and elderly care and health monitoring systems, artificial pacemakers, and hearing aids have been used.	Chronic diseases, Cardiovascular stroke, Dental health, Elderly, Problems and injuries caused by accidents and natural events	Creating communication between different medical resources and providing effective and reliable smart services to people Managing chronic diseases Providing indirect emergency medical services Detecting falling from the elderly bed Identifying drug incompatibility Providing child health information	The role of IoT in monitoring and controlling chronic diseases is highly important, and this technology plays a significant role in reducing injuries and hospital costs and increasing service delivery. For this reason, policymakers need to be aware of the role of this technology in the health of society.
Hematizade (52)	2020	Providing a control method (data integrity), which is one of the challenges of the IoT in health	Applied study	The sensors and tools in this technology exchange vital signs and emergency data such as HR and seizures or emergency events in medical centers and can exchange a wide range of data (e.g., images, texts, and numbers). Exchange medical centers	General health	Data integrity in the health network	The proposed method in this article is safe against all types of attacks, such as distortion and injection of unauthorized data, and can be an efficient integrity control system, and its applications can be used.
Rabeifar (53)	2022	Presenting a model based on IoT to investigate the role of accepting and using safer electronic health records in telemedicine and improving networks in it.	Qualitative study	Sensors and systems for identifying signals such as HR, BP, and the like and analyzing medical images	General health	Frequent electronic visiting Telecare Telemonitoring	The final model presented in this research has a direct impact on important treatment indicators such as error reduction and treatment duration, and the ability to transfer data on this platform leads to the smartness of telemedicine.
Karimi (54)	2022	Investigating the impact of IoT on improving the level of electronic health services for COVID-19 patients	Case study	By using smart wearables such as watches and wristbands and sensors equipped with the ability to record and send information, information related to the patient's physical characteristics and details can be made available to the doctor.	Chronic and cardiovascular diseases	Remote treatment of patients The possibility of identifying COVID-19 patients or those suspected of being infected Monitoring of people's body temperature and other vital signs in real-time Information transmission Instant release of information about the COVID-19 disease Reduction of hospital visits Increased possibility of access to medical services by the general citizens A map of dangerous and polluted places Compensation for the lack of healthcare	Improving the electronic health services of COVID-19 patients through the training of medical staff and the public, providing infrastructure, and taking other appropriate measures are positive tools, and the role of IoT in electronic health services is important.
Hosseinpour (55)	2020	Identifying and prioritizing the technological applications of IoT in the	Applied study	Devices equipped with sensors with the ability to record and send information related to the characteristics and details of the	COVID-19 pandemic	Monitor the patient's vital signs Inventory control of necessary equipment Supervision of employees	The quality of service was improved by making appropriate changes in information technology.

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		quality management of hospitals		patient's physical performance, such as smartwatches and smart wristbands, can inform doctors and specialists about the general condition of the patient.		Intelligent control and regulation of the environmental conditions for the storage of medicines and patients Reduction of hospital waste Monitoring of the physical activities of the elderly Online medicine and Internet medical consultation	
Karimi (56)	2022	Analyzing and identifying the applications of IoT in the face of epidemic diseases such as COVID-19	Case study	The use of cameras to identify, track, and monitor people infected with the COVID-19 virus, the use of self-driving (mobile) robots to disinfect medical and hospital equipment, the use of speakers, lights, smart security systems, and the like. Controlling vital signs using smart wristbands or a barometer sensor that determines the physical function of a person's body	Epidemic of infectious diseases (e.g., COVID-19)	Telemonitoring Intelligent diagnosis of COVID-19 patients Intelligent monitoring of vital signs and instant dispatch Daily reporting of the number of contacts with infected or suspected people Tracking and identification of contacts of infected employees with other employees in the organization Identification of affected people's place of residence and follow-up education, and hospital benefits without payment	IoT increases the quality of treatment and diagnosis, controls vital signs and supports decision-making, reduces hospital visits, and increases the possibility of monitoring the condition of patients during epidemics such as COVID-19.
Vahdat (57)	2018	Measuring the impact of using wearable sensor technology in the IoT environment in order to increase the general health of patients suffering from stress and fatigue	Survey study	Wearable devices that can monitor and notify some information about people with the help of their existing sensors (e.g., HR, BP, sleep monitoring, child growth measurement, and the like).	Stress and fatigue	The possibility of examining people and patients better and managing their daily activities better	Stress, fatigue, and people's behaviors can be improved by using wearable sensors to monitor people's movement and sleep and send appropriate warning messages.
Seyedi (58)	2019	Providing a method to increase the quality of service in wireless body sensor therapeutic networks by providing a protocol in the linkage layer based on the IoT	Applied study	Using wireless sensors and radio frequency identification	General health	Reducing care costs, early diagnosis of medical symptoms, and optimal use of hospital resources	The presented protocol has much better results in terms of delay, energy consumption, and throughput.
Sharafi (59)	2022	Providing a protocol based on the IoT to increase security in patient authentication	Applied study	A brain-computer interface using EEG signals is considered to identify the identity of the patient, and fingerprints are used for authentication	General health	Patient identification and authentication with high accuracy and speed	This protocol shows high security in identifying the patient, and the processing time has been reduced in the authentication phase.
Navaei (60)	2023	Designing a new sustainable test kit supply chain network utilizing IoT	Case study	Sustainable COVID-19 test kits supply chain networks using IoT. In addition, two meta-heuristic algorithms, namely, NSGA-II and PESA-II, are presented to solve the small, medium, and large size of the problem.	COVID-19 pandemic	Increasing the speed, accuracy, and security of the presented supply chain network Addressing the location-allocation-distribution problem for medical test kits for COVID-19	PESA-II is more efficient and has better performance than the others based on assessment metrics and computational time.
Ayyoubzadeh (61)	2023	Designing and developing remote monitoring of colorectal cancer survivors	Applied study	An Esp8266 as the IoT module in hardware	General medicine	Helping in obtaining quantitative and qualitative data from patients	The apps for remote colorectal patient monitoring could be designed to be useful.

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		using a smartphone app and an IoT-based device				and survivors to possibly provide better care	
Goodarzian (62)	2023	Designing an integrated responsive-green-cold vaccine supply chain network using IoT	Case study	The LP-metric method and meta-heuristic algorithms called gray wolf optimization and variable neighborhood search algorithms are used to solve the developed model.	COVID-19 pandemic	Enhancing the accuracy, speed, and justice of vaccine injection with the existing priorities and gathering data	Mountain Gazelle Optimizer offers higher quality and better performance than other proposed algorithms based on assessment metrics, computational time, and convergence.