

The review of usability evaluation methods on telehealth or telemedicine systems

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ABSTRACT

Introduction: Telemedicine in the pandemic of coronavirus disease 2019 (COVID-19) has responded to societal distancing in medical treatments by protecting health workers while also managing available resources. To attain best practices in telemedicine, a platform must be functional, and both patients and clinicians must be satisfied with the technology. To ensure the benefits of telehealth systems, usability refers to how easy the user interfaces of telehealth systems are to use. In this study, the usability of telemedicine systems has been investigated.

Material and Methods: The authors of this study review the study from 2015 to 2021 using a combination of the keywords "health", "telemedicine", "telemedicine", "mobile health", "usability" "Software", "System" and "Program", which led to the extraction of 119 articles in this field.

Results: Articles in the field of remote health software and evaluation of the usability of remote health applications in the form of applications based on mobile health technologies, web-based applications or a combination of both types with sample devices Primary are wearable electronics, sensors or robots.

Conclusion: In this study, most of the remote health software are mobile based and their usability has been evaluated by a questionnaire. Satisfaction is the most important usability attributes to consider when designing Health mobile apps.

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INTRODUCTION

The pandemic of coronavirus disease 2019 has resulted in adjustments to the way medical treatments and a quick shift toward telemedicine and telehealth to fill in the gaps in health care. Improved access, lower expenses, and a better patient experience are all advantages of telemedicine and telehealth. Telehealth categories include emergency care, medication-assisted treatment through telemedicine, telenutrition, telenursing, telepharmacy, teledentistry, teleneuropsychology, teleaudiology, teleneurology, telerehabilitation, teletrauma care, telecardiology, transmission of ECGs, telepsychiatry, teledermatology, teleradiology, telepathology, teleophthalmology, telesurgery,

teleabortion and other specialist care delivery [1]. Telehealth incorporates a wide range of technology and services focused on providing patient care and improving the overall healthcare delivery system. Telemedicine refers specifically to remote clinical services [1]. The mobile health is defined by the National Institutes of Health as "the use of mobile and wireless devices (cell phones, tablets, etc.) to improve health outcomes, health care services, and health research" [2]. The mobile health is a subset of the broader "telehealth" phrase that refers to a specific technique to use mobile technology to achieve better health outcomes [2-5]. A platform must be usable and both patients and clinicians must be satisfied with the technology [6] and to ensure the benefits of telehealth systems, usability has become an ever-

present and pressing issue for the research community and software developer [7]. Every stage of application design or update process is affected by usability concept. Usability is a measure of how easy and convenient to use a product and how useful to its users [3]. Usability is a quality method of calculating how simple user interfaces are to operate and evaluate how well a certain user in a specific setting can utilize a product or design to accomplish a defined goal effectively, efficiently, and successfully [4, 5, 8, 9]. Before starting the new design or upgrade an old model with a new model it is better work on usability. The usability of the health care system is a major determinant of its successful use and implementation [10].

The International Organization for Standardization (ISO) defines Usability as "the extent to which specific users use a method, product, or service to achieve specific goals with effectiveness, efficiency, and satisfaction in a particular field of use" [11, 12]. Usability standards were developed by ISO 9241-11 [13, 14]. Nielsen's Usability studies are used to develop health care systems and their acceptance by end users with concentrates on efficiency, effectiveness, and satisfaction [14].

The Shackel model in 1991 uses effectiveness, learnability, flexibility and attitude for usability. The Preece et al model in 1994 introduced three usability factors such as throughput, learning and attitudes. Shneiderman model in 1992 introduce the usability factors according to the interface design rules such as time to learn, performance speed, user mistake rate, maintenance over time, and satisfaction [15, 16]. The Constantine and Lockwood model in 1999 introduced a method for designing a user interface based on user focus on the purpose and use of patterns were introduced that cover factors of efficiency, learning, remembering, reliability in use and satisfaction [16]. The international Quality in Use Integrated Map (QUIM) model was introduced in 2006 with a combination of standard specifications ISO 9241 and ISO 9126 to introduce seven usability factors, including effectiveness, efficiency, satisfaction, safety, and accessibility.

The People at the Centre of Mobile Application Development (PACMAD) Model combines features of both the ISO and the Nielsen model and it used during the evaluation of mobile applications. There are several methods of usability evaluation that include Semi-structured interviews, Eye-tracking, Contextual interview, Cognitive walkthrough, Think-aloud, Focus group discussion, Heuristic Evaluation and expert review, Scenario, Questionnaires. There are many forms of standardized questionnaires such as mobile health APP usability questionnaire (MAUQ), System Usability Scale (SUS), Telehealth Usability Questionnaire, IBM ease of use questionnaires, Software Usability Measurement Inventory (SUMI),

Technology Acceptance Model-2 (TAM-2), Health Information Technology Usability valuation Scale (Health-ITUES), NASA Task Load Index (NASA TLX), the Post-Study System Usability Questionnaire (PSSUQ), and Questionnaire For User Interaction Satisfaction (QUIS) [17, 18]. This study aims to survey usability evaluation methods on tele health or telemedicine systems that run on the Web or Android platform and determine the variety of usability attributes in them.

MATERIAL AND METHODS

In this systematic review, the most essential phrase was "usability of the telehealth or telemedicine system". The scope was limited to English literature. Six digital databases were searched to find the target articles: IEEE Xplore, the Web of Science (WoS), Science Direct, PubMed, Google Scholar, and Elsevier's Scopus. In this study, a review was conducted to search for every article related to healthcare, apps, and usability to 2021. A mix of keywords containing "Healthcare", "Tele Health", "Tele Medicine", "mobile health" combined with the "OR" and "AND" operators followed by "Usability" and "AND "Software" and "OR" "System" and "OR" "Application" were used for search.

The initial query resulted in 350 papers. After reviewing the titles of the articles by two of the authors, 235 articles remained and after deleting the duplicate articles and reviewing the abstracts, 170 articles remained. In the final full-text review, 119 articles were included in the study of usability factors in health and health care, and to better explain the concepts and methods of papers in the final set in the study of usability factors in health and health care. The telemedicine system and how to check the usability of those system was assessed. Each article's authors, title, journal, year of publication, usability check model and abstract were entered into an excel file (Fig 1).

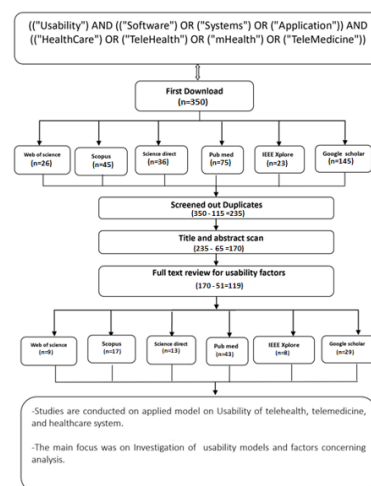


Fig 1: Flowchart of study selection

RESULTS

The telemedicine or telehealth systems in which their usability were assessed and included in this review are such as:

smoking cessation mobile apps, tele rehabilitation mobile apps, pain management mobile apps, cardiopulmonary resuscitation mobile apps, diabetes

care mobile apps, a self-management of anxiety and depression mobile apps, rheumatoid arthritis mobile apps, oncology cancer care mobile apps, hypertension Management mobile apps, urology care mobile apps, pediatric otolaryngology mobile apps, self-care for pregnant women.

The usability attributes which assessed in each of the articles are shown in Table 1.

Table 1: Usability factors

Usability Factors	References
Learnability	[15, 19-35]
Satisfaction	[19, 20, 25-27, 29-34, 36-96]
Efficiency	[19, 23, 25, 26, 28-35, 38, 40, 41, 43-45, 47, 53-56, 58, 59, 63, 65, 66, 69, 74, 75, 78-80, 82, 83, 86-89, 91, 93-95, 97-102]
Effectiveness	[13, 19, 20, 22, 23, 25-29, 32-35, 38, 40-44, 47, 53-56, 59, 60, 63, 65-67, 70, 74, 75, 78, 79, 81-83, 85-89, 91-96, 98, 99, 102-111]
Memorability	[35]
Errors	[21-23, 25, 27, 29, 76, 77, 79, 88, 98, 106, 107]
Safety	[20, 27, 56, 92, 106, 111-113]
Performance	[19, 20, 23, 25-28, 40, 45, 54, 65, 70-72, 77, 80, 82, 101, 106, 107, 112, 114, 115]
Design	[19-23, 25-33, 35, 40, 42-44, 53, 54, 65, 69, 71, 72, 76-79, 81, 82, 85, 88, 91, 92, 95, 97, 98, 101, 103-105, 107, 109, 110, 112, 114-117]
Navigation	[13, 19-23, 25, 27-33, 35, 38, 40, 42, 43, 49, 53, 54, 66, 67, 72, 75, 79, 80, 82, 83, 88, 91, 106, 107, 109, 114, 117]
Compatibility	[19, 45, 71, 76, 106]
Visibility	[29, 45, 97, 106, 107, 114]

The usability evaluation methods which assessed in each of the articles are shown in Table 2.

DISCUSSION

This study aims to survey usability evaluation methods on tele health or telemedicine systems that run on the Web or Android platform and determine the variety of usability attributes in them. This review focused on the usability evaluation of applications or software designed for telehealth, telemedicine, and health care systems such as telecare monitoring system, mobile applications for Pain Assessment and Management, self-management of hypertension, HIV Interventions, Diabetes, Multiple Sclerosis, Cancer, cardiovascular disease, supporting health care during pregnancy, Psychological Experiences of Web-Based Psychosocial Interventions, interventions for substance use disorder [57, 99].

The results of this study show that mobile phones were the most used because mobile phones can both connect to sensors, run mobile applications, and receive and store data and information and send to o

the server located in the health care center for monitoring by health care providers. Mobile apps have a great potential to support patients in healthcare, and to encourage healthy behavioral changes, a set of factors that has impact on the app effectiveness is related to the quality of those features that lead to positive user experiences when using the app. there are so many health mobile apps available, but app usage by patients is low [100], Evaluation of Mobile application usability may be influenced by patient factors such as age, sex, and psychological needs. Mobile Apps can help patients connect with health care providers by supporting email communication and sharing home-monitored data [100]. The need for mobile health approaches to address particular aging features of older adults grows as the population of older adults as a possible consumer group of mobile health grows [10].

The World Health Organization's Global Observatory for eHealth defines mobile health “medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants, and other wireless devices” [118].

Table 2: Usability methods

Usability Evaluation Method		Articles
Interview	Interview	[13, 14, 16, 20, 25, 26, 36-44, 47, 49, 53, 54, 57-59, 97-99, 103-105, 114, 116]
	Semi Structured Interviews	[13, 37, 39, 50, 51, 58, 62, 64, 66, 99, 114]
	Qualitative Interview	[45, 55, 57, 59, 103, 105]
	Post study phone interview	[28, 36]
questionnaire	Questionnaire	[19, 25-32, 45, 46, 48, 54-57, 60, 64-66, 69-71, 77, 78, 80-82, 85, 90-92, 101, 107, 113, 115, 117, 119, 120]
	Post-Study System Usability Questionnaire (PSSUQ)	[27, 45, 76, 79, 98]
	Computer Systems Usability Questionnaire (CSUQ)	[36, 61, 80, 84]
	Telehealth Usability Questionnaire	[34, 94, 96, 108]
	System Usability Scale (SUS)	[19, 22, 46, 48, 50, 51, 63, 64, 67, 77, 79, 85, 89, 99, 100, 106, 109, 112]
	Technology Acceptance Model-2 (TAM-2)	[77]
	Client Satisfaction Questionnaire-8, (CSQ-8)	[52]
	User Experience Questionnaire (UEQ)	[65]
NASA Task Load Index (NASA TLX)		[84, 106]
Observations		[37, 47, 50, 51, 55, 60, 66, 68, 69, 118]
Descriptively Reported		[55, 56]
Expert Review		[46]
Think a Loud		[45, 47, 67]
Eye Tracking		[21, 67]
Motion tracking device		[21, 67, 69]

Smartphones have made it easier for healthcare practitioners and the general population to collaborate, gathers data, and makes clinical decisions [22, 88]. The need for mobile health approaches to address particular aging features of older adult's increases as the population of older adults as a potential user group grows. Usability research, however, indicate that mobile health is still not planned properly for older adults and their preferences [87, 117]. Older patients are a significant target population for Web-based health information since numerous ailments, such as cancer, diabetes, and hypertension, are diseases that affect the elderly. In elderly individuals who access Web-based health information, improvements in self-efficacy, blood pressure, hemoglobin levels, and cholesterol levels have been noted [69, 83].

To evaluate the usability of mHealth apps, the most common data collection technique utilized in the studies was questionnaire, followed by field study, interview, observation, think-aloud, and app-use generated data.

The SUS was the most common standard questionnaire used by the studies in the review. The SUS, the Usefulness, Satisfaction, and Ease of Use (USE) Questionnaire, and the Post Study System Usability Questionnaire were the most commonly used scales that studies used to create their own questionnaires.

In this review, we found that questionnaire was the most common data collection technique of the included studies; however, researchers either used standard questionnaires, such as SUS or USE, which were not specifically designed for the mental health domain, or adapted a standard questionnaire or developed a new one. Owing to the great variety of the questionnaires, there is a need to establish a common standardized usability questionnaire targeted specifically at mHealth apps.

Tele Health and Telemedicine are a timely response to the limitations that COVID-19 societal distancing imposes on traditional healthcare delivery methods and the COVID-19 pandemic is favoring digital transitions. Health-care organizations quickly

adopted digital solutions and advanced technology tools in response to the pandemic's first phase. Telehealth has emerged as a critical component of patient healthcare delivery during the COVID-19 pandemic.

Telehealth can help with enhancing compliance and clinical efficiency, as well as reducing in-person contacts for clinical routes, which is critical during the COVID-19 epidemic [68, 82]. In the most of the reviewed articles, the factors of the ISO model, 9241-11, or Dr. Nielson's model were used to evaluate the usability of the telehealth systems. The effectiveness, efficiency, satisfaction, learnability, memorability, and errors factor were measured in the majority of the reviewed articles, but given the issue of telehealth and the fact that users vary depending on the type of disease and care or intervention required, age and physical condition must improve the usability of systems for upgrading. To make the system designed for users more usable, it is suggested that the usability of telehealth systems be evaluated using twelve factors [16]. Questionnaires are the most often used approach for evaluating health-care systems. The results showed that Satisfaction, Efficiency, Design and Effectiveness are the most important usability attributes to consider when designing Health mobile apps. the authors had previously designed a telemedicine system for heart control for diabetics [121, 122], but its usability had not been studied, so for future work, they will decide to design a telehealth system and study its usability

based on the usability evaluation model with twelve factors included Learnability, Satisfaction, Efficiency, Effectiveness, Memorability, Errors, Safety, Performance, Design, Navigation, Compatibility, and Visibility [121, 122].

CONCLUSION

This study provides usability evaluations methods and usability attributes in telemedicine or telehealth systems especially mhealth apps. the mhealth apps are the most developing due for the availability of mobile devices to users, their popularity, and device affordances. the standard questionnaires are the most used for systems usability evaluation. the satisfaction, efficiency, design and effectiveness are the most important systems usability attributes.

AUTHOR'S CONTRIBUTION

All authors contributed to the literature review, design, data collection and analysis, drafting the manuscript, read and approved the final manuscript.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest regarding the publication of this study.

FINANCIAL DISCLOSURE

No financial interests related to the material of this manuscript have been declared.

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