



(REVIEW ARTICLE)



Bibliometric review of telemedicine interface design for accessibility of monitoring current condition in healthcare services

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World Journal of Advanced Research and Reviews, 2023, 17(01), 501–510

Publication history: Received on 04 December 2022; revised on 10 January 2023; accepted on 13 January 2023

Article DOI: <https://doi.org/10.30574/wjarr.2023.17.1.0062>

Abstract

Distance plays a significant role in the utilization of telemedicine, which uses digital communication technologies in healthcare. Medical professionals can remotely monitor, assess, diagnose, and treat patients using information and telecommunications technologies. Another element that helps people utilize telemedicine services is developing an intuitive application display design. Selection series through 1688 publications and 608 publications in the Scopus Database that satisfy the required criteria (publications from 2012 to 2023 using keywords: "telemedicine" AND "interface" AND "design" AND "monitoring" AND "elderly" and in medically linked fields of research). VOSViewer was used to evaluate the data and create 4 full clusters. The majority of the studies took place in America. Wearable technology in patients undergoing medical rehabilitation is the topic of the most cited article. The primary issues of the article are explained together with the cluster themes evaluated, such as: telemedicine interface design and remote patient monitoring. It is necessary to conduct additional research using a comparable methodology to further develop fresh concepts for enhancing the caliber of healthcare services.

Keywords: Design; Elderly; Interface; Monitoring; Telemedicine

1. Introduction

Distance is a crucial consideration in the practice of telemedicine, which is the use of digital communication technology to deliver and promote health and health-related services [1]. This calls for the proper sharing of data on the diagnosis, management, prevention of illness and damage, health information, patient education, research, and training [2]. Medical professionals can analyze, diagnose, and treat patients remotely using information and telecommunications technologies. Recent advancements in telemedicine are quickly making it a significant part of medical practice and research [3][4]. To provide diagnosis, treatment, consultation, and training, telemedicine integrates medicine, telecommunications, information technology, and education [5][6].

In essence, it is a form of telemedicine that may offer high-quality medical treatments whenever and wherever needed. The ease of use of the service increases with the simplicity of the telemedicine interface on the user's device, which increases early disease detection and lowers treatment costs for more serious diseases [7][8]. The term "telehealth" describes a number of tools and services designed to enhance patient care across the board. In comparison to telemedicine, telehealth offers a greater choice of services [9]. Telemedicine has been employed in rural and remote emergency departments to help with patient management [10]. Although telehealth can also apply to virtual non-clinical services like supplier training, administrative appointments, and continuing medical education, telemedicine often refers to remote clinical services [11][12]. Monitoring, health promotion, and public health care are all included in telehealth, according to the World Health Organization [13].

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2. Research Method

Gathering research articles in the Scopus Database that contain the keywords "telemedicine", "interface", "design", "monitoring", and "elderly" is the first phase in the research process (n=1688). In the following stage, publications between the years of 2012 and 2023 (n=1464) will be excluded from the search. The third step is to focus the literature search on the research topic, which is medicine (n=615). The search is finally restricted depending on the language of publication, which in this case is English (n=608). The data is examined using the VOSviewer program after the last stage of the search to determine network patterns or the distribution of themes, years, and authors across all publications used.

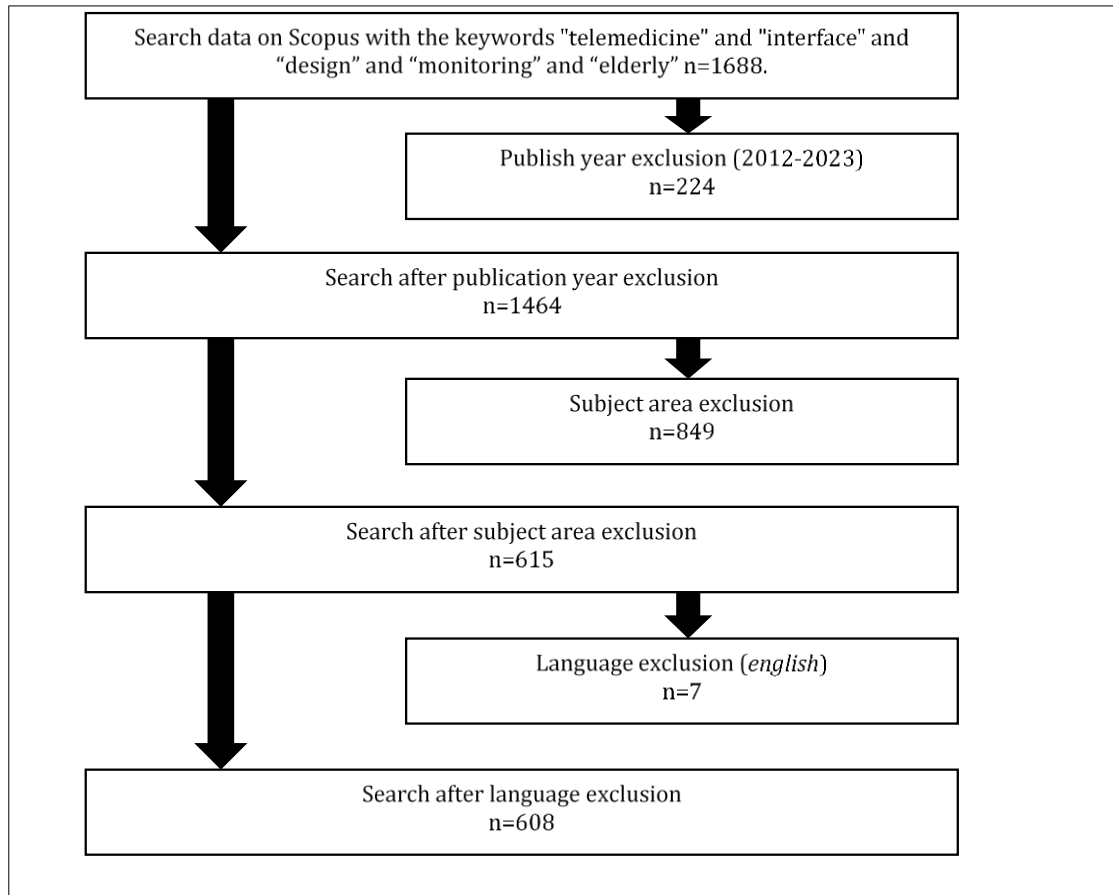


Figure 1 Publication Selection Scheme

2.1. Research Strategy

(ALL (telemedicine) AND ALL (interface) AND ALL (design) AND ALL (monitoring) AND ALL (elderly)) AND (LIMIT-TO (PUBYEAR , 2023) OR LIMIT-TO (PUBYEAR , 2022) OR LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-TO (PUBYEAR , 2012)) AND (LIMIT-TO (SUBJAREA , "MEDI")) AND (LIMIT-TO (LANGUAGE , "English")))

3. Results

Figure 2 shows the pattern of the number of scientific publications per year. Highest number of publications found in 2021 (78). In Table 1, it can be seen that the most citations in 2021 discussed about wearable device using sensors is discussed for achieving telemonitoring of older adults with chronic disease. Lowest number of publications found in 2012 (35). The most citations in 2012 discussed about healthcare application for smartphone.

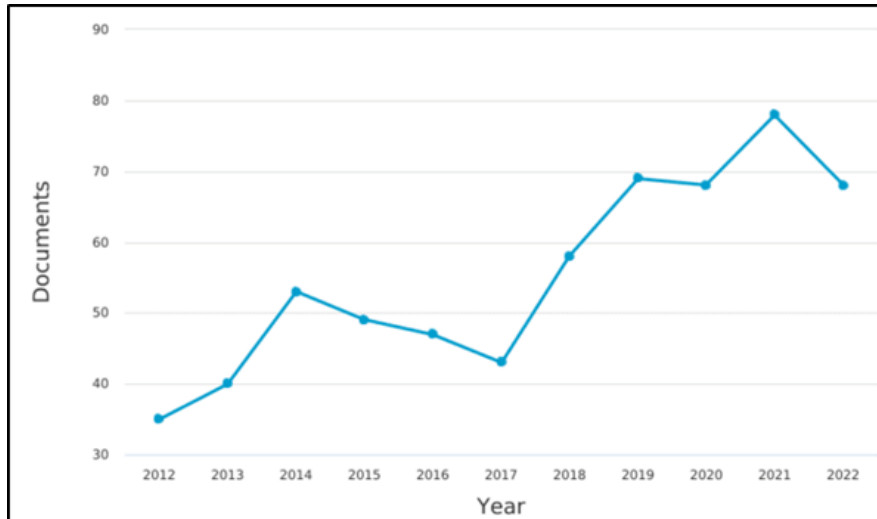


Figure 2 Number of publications by year

Table 1 Number of Citations by 2012 and 2023

Document	Year	First Author	Citations
A review of wearable sensors and systems with application in rehabilitation	2021	Patel, S [11]	1422
Wearable physical activity tracking systems for older adults-A systematic review		Vargemidis, D [14]	9
Security and privacy issues in wireless sensor networks for healthcare applications	2012	Al Ameen, M [15]	442
TElehealth in CHronic disease: Mixed-methods study to develop the TECH conceptual model for intervention design and evaluation		Salisbury, C [16]	43

The 1688 papers considered in this analysis cover the topics shown in Figure 3 in more detail. Health professions (147), computer science (124), engineering (102), nursing (62), and social science are the most popular subjects (33). In the study, as indicated in Table 2, the three topic areas (medicine, health professions, and computer sciences) similarly had high citation rates. Chemistry (1), environmental science (2), dentistry (2), mathematics (3), business management and accounting (4), and decision sciences are the subjects with the fewest of them (4).

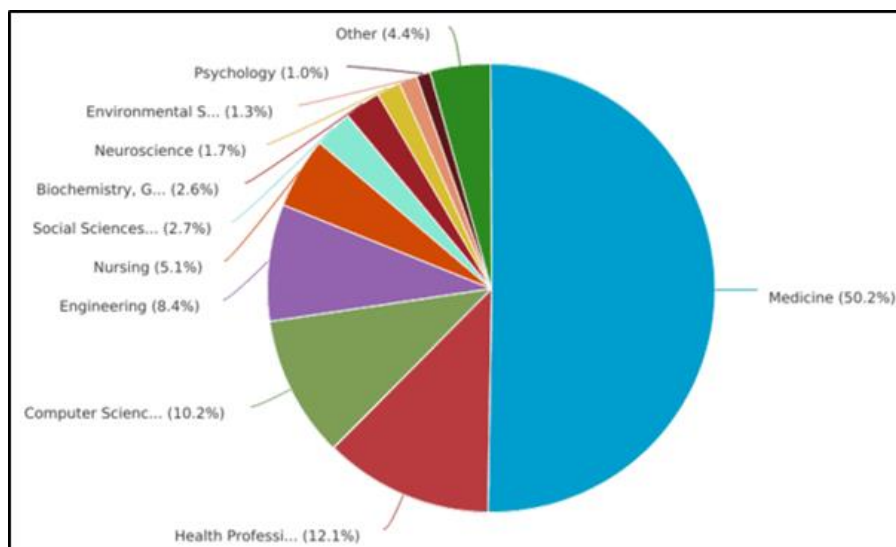


Figure 3 Number of publications by subject area

Table 2 Citation of publications by subject area

Title	Author and Year	Source	Subject Area	Citations
A review of wearable sensors and systems with application in rehabilitation	(Patel et al., 2012) [11]	Journal of NeuroEngineering and Rehabilitation 9(1),21	Medicine	1422
A systematic review of healthcare applications for smartphones	(Mosa et al., 2012) [17]	BMC Medical Informatics and Decision Making 12(1),67		755
Security and privacy issues in wireless sensor networks for healthcare applications	(Al Ameen et al., 2012) [15]	Journal of Medical Systems 36(1), pp. 93-101		442
Systematic review of Kinect applications in elderly care and stroke rehabilitation	(D & O., 2014) [18]	Journal of NeuroEngineering and Rehabilitation 11(1),108		303
Security and privacy issues in wireless sensor networks for healthcare applications	(Al Ameen et al., 2012) [15]	Journal of Medical Systems 36(1), pp. 93-101	Health professions	442
Empirical Studies on Usability of mHealth Apps: A Systematic Literature Review	(Zapata, B.C et al., 2015) [19]	Journal of Medical Systems 39(2),1, pp. 1-19		302
The adoption and implementation of RFID technologies in healthcare: A literature review	(Yao et al., 2012) [20]	Journal of Medical Systems 36(6), pp. 3507-3525		193
A systematic review of the technology acceptance model in health informatics	(Rahimi et al., 2018) [21]	Applied Clinical Informatics 9(3), pp. 604-634		185
A systematic review of healthcare applications for smartphones	(Mosa et al., 2012) [17]	BMC Medical Informatics and Decision Making 12(1),67	Computer Science	755
Smart wearable systems: Current status and future challenges	(Chan et al., 2012) [22]	Artificial Intelligence in Medicine 56(3), pp. 137-156		631
Security and privacy issues in wireless sensor networks for healthcare applications	(Al Ameen et al., 2012) [15]	Journal of Medical Systems 36(1), pp. 93-101		442
Empirical Studies on Usability of mHealth Apps: A Systematic Literature Review	(Zapata, B.C et al., 2015) [19]	Journal of Medical Systems 39(2),1, pp. 1-19		302
Safer healthcare: Strategies for the real world	(Vincent & Amalberti, 2016) [12]	Safer Healthcare: Strategies for the Real World pp. 1-157	Engineering	207
A framework for daily activity monitoring and fall detection based on	(Cheng et al., 2013) [23]	IEEE Journal of Biomedical and Health Informatics 17(1), pp. 38-45		153

surface electromyography and accelerometer signals			
Mechano-acoustic sensing of physiological processes and body motions via a soft wireless device placed at the suprasternal notch	(Lee et al., 2020) [24]	Nature Biomedical Engineering 4(2), pp. 148-158	140
Mobile healthcare applications: system design review, critical issues and challenges	(Baig et al., 2015) [25]	Australasian Physical and Engineering Sciences in Medicine 38(1), pp. 23-38	139

Themes (Figure 4) and year of publication (Figure 5) data analysis was done using VOSviewer. The issue of telemedicine interface design and monitoring in health services was mapped using a total of 4 clusters after the data was examined. The four clusters are identified by their number, theme, and color using network visualization provided by VOSviewer. The complete cluster (72) is made up of clusters 1 (25), 2 (23), 3 (14), and 4 out of all the topics (10). The cluster topics are listed in Table 3.

Table 3 Publication Theme Cluster

Cluster	Description	Amount
Cluster 1	Artificial intelligence, delivery of health care, ehealth, health care, interpersonal communication, medical informatics, software, telehealth, telemonitoring.	25
Cluster 2	Adult, daily life activity, elderly care, self-help devices, outcome assessment, exercise	23
Cluster 3	Computer interface, home care services, information processing, physiologic monitoring, wireless communication	14
Cluster 4	Mobile application, smartphone, usability	10

Artificial intelligence, healthcare delivery, eHealth, interpersonal communication, medical informatics, software, telehealth, and telemonitoring are some of the issues covered by Cluster 1. Adult evaluation, daily living activities, geriatric care, exercise, outcome assessment, and self-help devices are all included in the Cluster 2 theme. Computer interfaces, home care services, information processing, physiological monitoring, and wireless connectivity are some of the themes in Cluster 3. Usability, mobile applications, and smartphones are all part of the Cluster 4 concept.

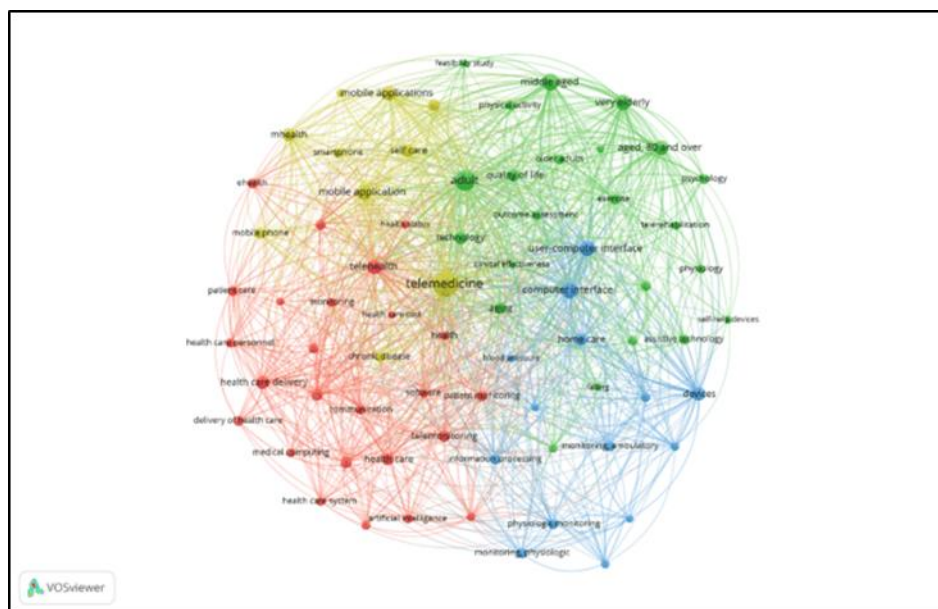


Figure 4 VOSviewer Network Visualization

A graphic representation of the published themes used by year is shown in Figure 5. The topics of *mHealth*, *healthcare delivery*, *mobile applications*, *artificial intelligence*, and *technology* are some of the publication themes that are frequently fresh. Computer interface, home care services, wireless technology, equipment design, medical computing, gadgets, and computer program are among the long-published topics.

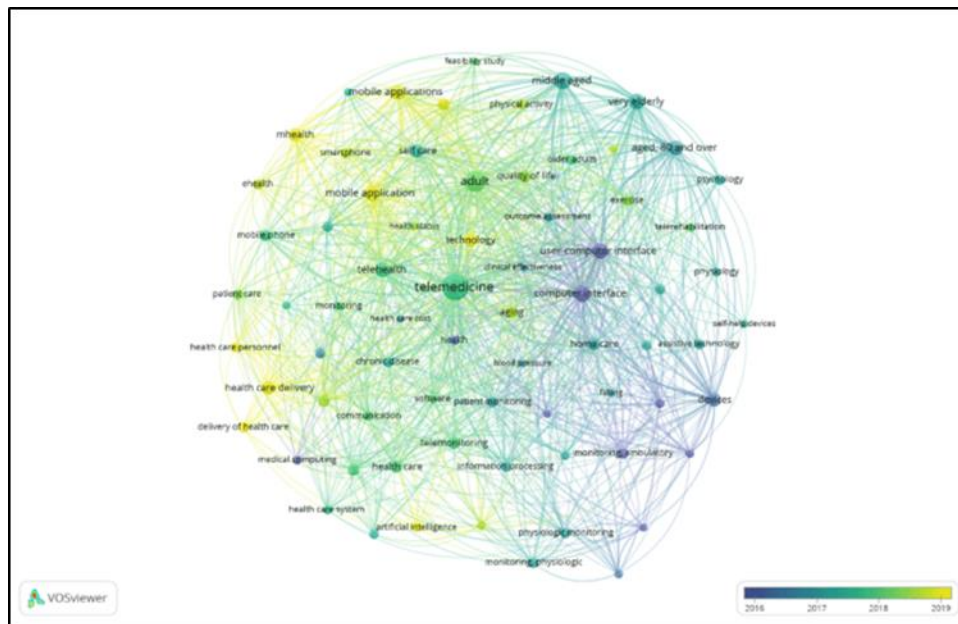


Figure 5 VOSviewer Overlay Visualization

A density visualization of all of the 608 publications' core themes is shown in Figure 6 of this article. According to the analysis's findings, the total number of publications utilized frequently includes topics like telemedicine, telehealth, home care, user computer interface, health care, mobile application, and extremely elderly. Usability, remote sensing, aged care, wireless communication, health services, equipment design, and independent living are topics that are rarely discussed in the publications used.

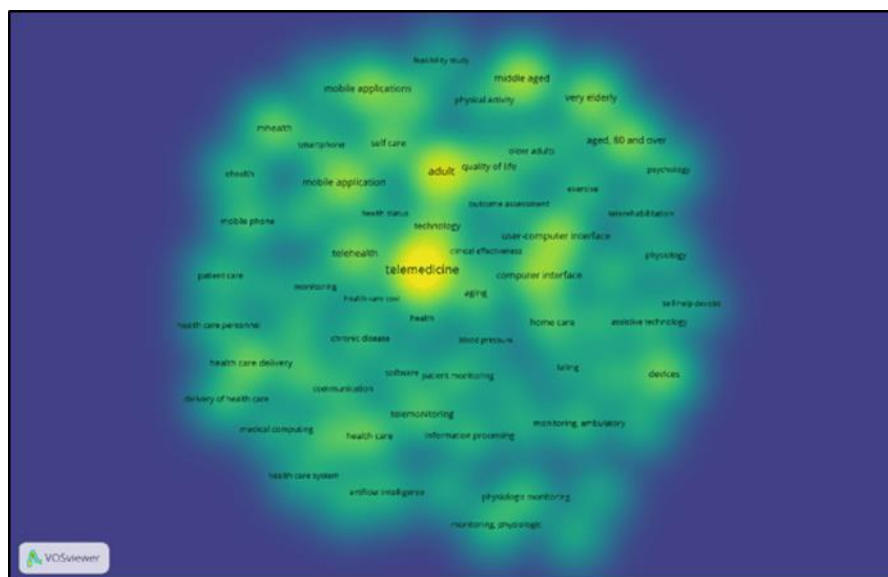


Figure 6 VOSviewer Density Visualization

According to Figure 4's subject maps, the publications with the most citations on telemedicine, telehealth, telemonitoring, computer interface, user interface, and adult are grouped together in Table 4. The publications with the most citations discuss smart wearable devices for monitoring current health conditions and predicting future health

conditions, such as a review of wearable devices with applications in rehabilitation [11], and a systematic review of healthcare applications for smartphones [17].

Table 4 Publications with the highest number of citations

Title	Author and Year	Source	Citations
A review of wearable sensors and systems with application in rehabilitation	(Patel et al., 2012) [11]	Journal of NeuroEngineering and Rehabilitation 9(1),21	1422
A systematic review of healthcare applications for smartphones	(Mosa et al., 2012) [17]	BMC Medical Informatics and Decision Making 12(1),67	755
Smart wearable systems: Current status and future challenges	(Chan et al., 2012) [22]	Artificial Intelligence in Medicine 56(3), pp. 137-156	631
Security and privacy issues in wireless sensor networks for healthcare applications	(Al Ameen et al., 2012) [15]	Journal of Medical Systems 36(1), pp. 93-101	442
ICU admission, discharge, and triage guidelines: A framework to enhance clinical operations, development of institutional policies, and further research	(Nates et al., 2016) [26]	Critical Care Medicine 44(8), pp. 1553-1602	314
Systematic review of Kinect applications in elderly care and stroke rehabilitation	(D & O., 2014) [18]	Journal of NeuroEngineering and Rehabilitation 11(1),108	303
Empirical Studies on Usability of mHealth Apps: A Systematic Literature Review	(Zapata et al., 2015) [19]	Journal of Medical Systems 39(2),1, pp. 1-19	302

4. Discussion

We discovered numerous significant conversations in the articles throughout the cluster themes evaluated from 2012 to 2023. Telemonitoring has the greatest potential to limit a patient's access to medical care if they have a medical issue [27] [28]. It is vital to perform a thorough and ongoing user survey to determine whether the monitoring application software used for remote healthcare is user-friendly in order to achieve and maintain these attributes [29]. One of the primary determinants for patient compliance in following the advice offered by medical professionals through the application, according to the most widely cited publishing journal in the bibliometric study above, is the appearance of a straightforward and understandable application [9][30]. In-depth interviews with telemonitoring users and focus group discussions by users are suggested approaches to create an application display that is user-friendly and tailored to their preferences [31]. The anticipated result of group discussions and in-depth interviews regarding the accessibility of telemonitoring displays on the user's screen is that officers can directly observe telemonitoring users' conditions without having to personally interact with them [32][33]. This will allow for immediate first aid to be given in the event of an emergency [34]. The variety of actions, together with the security risks and difficulties, enable healthcare institutions to appropriately treat patients [35].

This is also mentioned in journals that discuss wearable devices as telemonitoring of rehabilitation patients; this journal has received the most citations, with 1422 from 2012 to 2023. In some studies, wearable devices are an effective tool for monitoring a patient's vital condition without having to report their condition first [11][36]. For some reason, it is desirable in the telemonitoring process for a family member or close relative of the patient to engage in monitoring the patient's vital signs and software usage. This person must comprehend the patient's situation [29]. To evaluate the appearance and results of remote monitoring in order to improve its use in the field in the future, periodic training and assessments can be conducted [37][38]. A survey team is reportedly required to create a telemonitoring display model for patients and healthcare professionals who use telemedicine services, according to many journals. These efforts are done to uphold the standard and safety of behavior in a healthcare facility's environment [39].

5. Conclusions

A significant service that can currently be used in healthcare is telemedicine. Telemedicine has the potential to increase efficiency while also maintaining quality and security. Health service professionals can work together to address issues and strengthen the telemonitoring facility going forward. In order for health service providers to readily contact patients who are far from health facilities and vice versa without incurring excessive fees for delivering health services, patients' ease of access to telemedicine can offer good service. Future studies using a comparable methodology are required to provide fresh concepts for raising the caliber of healthcare services.

Compliance with ethical standards

Funding

No outside funding has been provided for this study.

Disclosure of conflict of interest

No conflicts of interest exist.

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