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Review

Effect of Digital Intervention on Chemotherapy Adherence: A Systematic Review

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Abstract

Introduction: Chemotherapy is typically administered in specific doses and schedules to maximize its effectiveness in killing cancer cells. If a patient does not adhere to the prescribed regimen, the treatment may be less effective, potentially allowing the cancer to grow or spread. Digital interventions offer innovative approaches to address the issue of adherence. The aim of this study is to analyze the effect of digital interventions on enhancing cancer patients' adherence to chemotherapy.
Methods: This systematic review analyzed full-text original articles published in English. Articles were searched in databases including Scopus, PubMed, Web of Science, CINAHL, and ProQuest from 2018 to February 2024. The articles were identified using the keywords: (telehealth OR telecare OR telenursing OR "smart application" OR "mobile application") AND (adherence OR "treatment adherence") AND (chemotherapy OR "adjuvant chemotherapy" OR "drug therapy") AND (cancer OR neoplasm*). Bias was assessed using the Critical Appraisal Skills Program (CASP) tool.
Results: A total of 456 items were found. Thirteen relevant papers from the literature search focused on breast cancer patients. The number of participants across all studies was 2,289. Examples of digital interventions used included mobile games, video conferences, text messaging related to mobile health, and apps. These interventions provided medication reminders, symptom reporting, adherence tracking, and patient education, all of which contributed to increased chemotherapy adherence.
Conclusion: Digital interventions positively influence chemotherapy adherence in cancer patients. The use of technology enables patients to actively participate in their treatment. This review was conducted across various continents, making the findings applicable to diverse ethnicities and races.

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INTRODUCTION

Chemotherapy is one of the interventions used to treat cancer [1]. It offers therapeutic benefits to cancer survivors through its cytotoxic properties, which primarily target the division and multiplication of cancer cells. However, chemotherapy also affects fast-growing healthy cells, such as those in the mucosa, hair follicles, and epithelial tissue, leading to negative side effects for cancer survivors [2]. Side effects from chemotherapy can include nausea, vomiting, hair loss, diarrhea, decreased appetite, fatigue, febrile neutropenia, mouth ulcers, pain, constipation, and bleeding [3]. These discomforts often make patients undergoing chemotherapy feel uncomfortable, which can negatively impact their adherence and continuity of treatment [4].

The long course of chemotherapy underscores the severity of the treatment, especially with the increasing number of cancer cases worldwide. According to the World Health Organization (WHO), the three most common types of cancer globally, based on the number of new cases in 2020, were breast cancer (2.26 million cases), lung cancer (2.21 million cases), and colorectal cancer (1.93 million cases). In terms of cancer-related deaths, lung cancer ranked first with 1.8 million deaths per year, followed by colorectal cancer, which caused 916,000 deaths in 2020 [5]. In Southeast Asia, cancer cases in 2018 reached 2 million, with cancer-related deaths totaling 1.3 million. The three cancers with the highest incidence and mortality were breast, lung, and cervical cancer [6]. A similar situation is observed in Indonesia, where cancer is a significant health issue. In 2018, the most common cancers in Indonesia were breast, cervical, and colorectal cancer, while the highest mortality rates were from lung, breast, and liver cancer [7].

Most cancer patients receive adjuvant chemotherapy, which can be administered both parenterally and orally [8]. However, the lengthy chemotherapy process, coupled with various side effects, often leads to non-adherence. Failing to take medication as prescribed or not following the chemotherapy schedule can result in treatment failure, making it difficult to evaluate the therapy's success, and can increase both morbidity and mortality. This non-compliance can also lead to the replacement of the chemotherapy regimen with parenteral administration, which may be more difficult for the patient [9]. Therefore, improving chemotherapy adherence in cancer patients requires attention, particularly by leveraging technological advancements that can be easily accessed by patients.

The growing availability of technology can aid in medication adherence and help establish a holistic, patient-centered nursing model. Digital technology can be most effective when healthcare providers empower patients, thus improving the quality of care [10]. Previous research has explored educational applications focused on oral chemotherapy, including a menu for reporting side effects, though these apps lacked a reminder feature. The results showed no significant improvement in adherence, even though there was an increase in patient engagement [11]. Other studies have developed short message service (SMS)

reminders for taking oral chemotherapy drugs, significantly increasing patient compliance with chemotherapy treatment [10]. However, traditional media such as leaflets and posters are insufficient for patient education [12].

According to the Health Promotion Theory, an individual's commitment to health-promoting behaviors is influenced by previous behaviors, which can be modified by reinforcing the belief in the positive outcomes expected from the action (perceived benefit of action). Several studies have investigated the effectiveness of digital applications in improving chemotherapy adherence among cancer patients. One study developed an educational app about oral chemotherapy, including a feature for reporting side effects, but it lacked a reminder function. This resulted in no significant increase in compliance, despite better patient engagement [11]. Another study created a mobile app with a reminder feature, but it was not fully optimized for patients on interval dosing schedules. The app used only reminders and did not include a medication calendar, making it difficult for these patients to keep track of their schedules [13]. Research on SMS-based interventions for managing chemotherapy side effects also has limitations, as the intervention relied solely on text messages and lacked audiovisual content. Additionally, patients were unable to send reply messages in response to the information provided [14]. Therefore, a systematic study is needed to evaluate the effectiveness of digital interventions in improving chemotherapy adherence among cancer patients.

METHODS

Search strategy

A literature search was conducted from the study's inception using five databases: Scopus, PubMed, Web of Science, CINAHL, and ProQuest. The results were written following the protocols and guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Articles and journals were searched using keywords and Boolean operators (AND, OR, NOT, and AND NOT), which helped expand or refine the search to better identify the relevant articles and the desired quantity. The keywords used in the systematic review were aligned with the Medical Subject Headings (MeSH) and included the following terms: (telehealth OR telecare OR telenursing OR "smart application" OR "mobile application") AND (adherence OR "treatment adherence") AND (chemotherapy OR "adjuvant chemotherapy" OR "drug therapy") AND (cancer OR neoplasm*). The article search strategy was designed using the PICOS framework (Table 1).

Table 1. PICOS Framework

PICOS framework	Inclusion Criteria	Exclusion Criteria
Population	Cancer patients over 19 years of age undergoing chemotherapy	Non-human experiment
Intervention	Digital based intervention	Conventional educational interventions
Comparator	No comparison	
Outcomes	Chemotherapy adherence	Didn't discuss chemotherapy compliance
Study Design and publication type	Randomized control trial (RCTs), Experimental Design	Review and analysis: literature review, systematic review, meta-analysis
Publication Years	From study inception to February 2024	
Language	English	

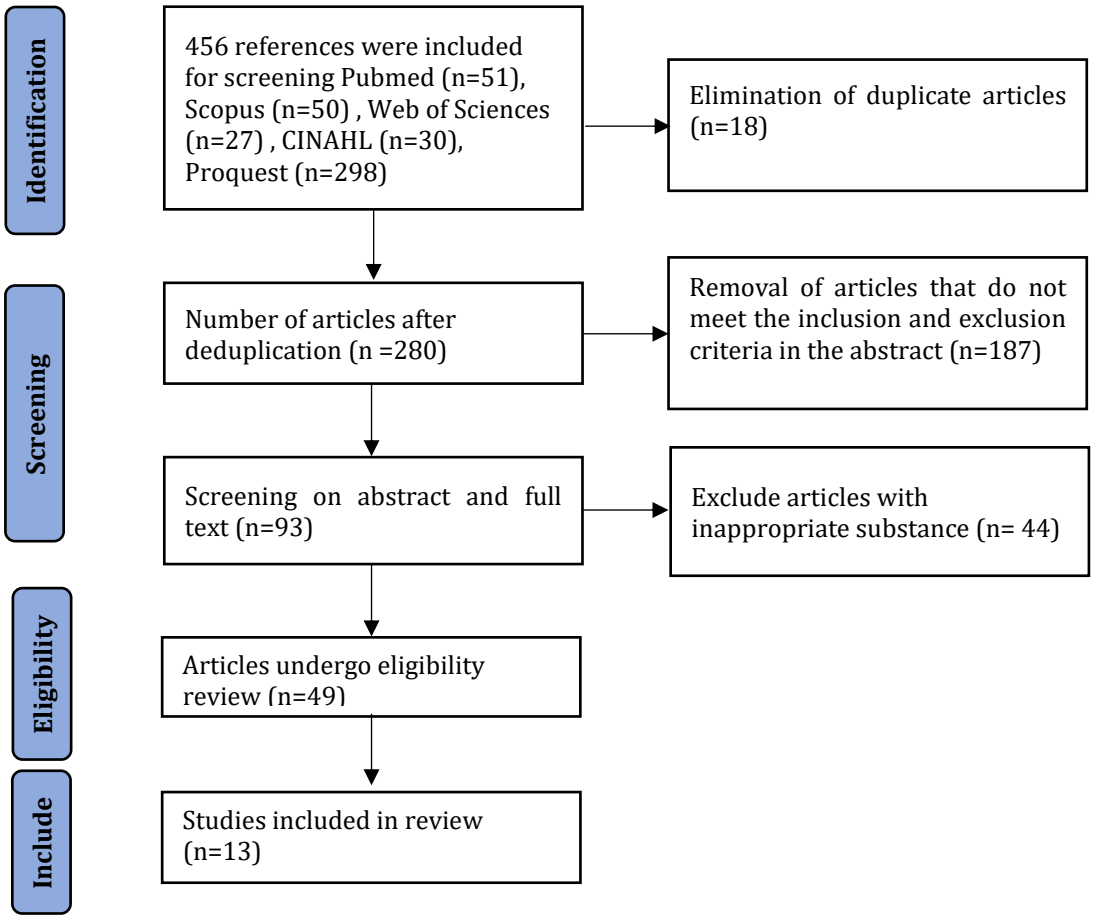

Fig. 1. Literature Screening Flowchart

The inclusion criteria for this study were articles published between 2018 and February 2024, using the Experimental Design method. Based on the keyword search and subsequent selection process, 13 articles were chosen from an initial pool of 456 articles. The selection process followed the PRISMA guidelines (Fig. 1), which involved searching databases, removing duplicate articles, screening abstracts, and excluding those that did not meet the criteria. Full-text articles that met the inclusion and exclusion criteria were then further evaluated.

Quality assessment of studies

To assess the risk of bias in each study, the Critical Appraisal Skills Program (CASP) tool was used. Each study's CASP score was calculated and evaluated, with studies meeting at least 70% of the critical appraisal criteria being included in the final analysis. The cut-off point for inclusion was agreed upon by the study researchers. The results of the risk of bias assessment are shown in Table 2.

Table 2. Quality Assessment Using a CASP Quality Assessment Tool

Study	**Q 1**	**Q 2**	**Q 3**	**Q 4a**	**Q 4b**	**Q 4c**	**Q 5**	**Q 6**	**Q 7**	**Q 8**	**Q 9**	**Q10**	**Q11**	Total score	Category
[15]	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	10/13	Good
[16]	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	10/13	Good
[17]	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	10/13	Good
[18]	Y	N	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	8/13	Fair
[19]	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	10/13	Good
[11]	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	10/13	Good
[20]	Y	N	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	9/13	Fair
[21]	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	11/13	Good
[22]	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	11/13	Good
[23]	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	11/13	Good
[24]	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	10/13	Good
[25]	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	10/13	Good
[26]	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	10/13	Good

RESULT

Fig. 1 provides an illustration of the literature search and selection process, including explanations for study exclusions. After removing duplicates, a total of 280 original articles were identified, with 13 articles ultimately included in the systematic review.

Article Characteristics

Fig. 1 illustrates the literature search and selection method. After removing duplicates, 280 original articles were identified, and 13 articles were finally included in the systematic review. The review includes research conducted in the United States

(n=5), Korea (n=2), China (n=1), Turkey (n=1), Norway (n=1), Australia (n=1), Spain (n=1), and a collaborative study from Norway, Austria, Greece, the Republic of Ireland, and the United Kingdom (n=1). All studies involved cancer patients, with the majority focusing on breast cancer (n=11), followed by gastrointestinal cancer (n=1) and lung cancer (n=1). The studies were published in 2018 (n=2), 2019 (n=2), 2020 (n=2), 2021 (n=3), 2022 (n=2), and 2023 (n=2). Most studies reported positive effects on medication adherence, while two studies found no significant difference.

Digital intervention approaches

The digital intervention approaches varied across the 13 included studies. Seven studies (53.8%) used mobile application-based management, 1 (7.7%) used a web-based platform, 1 (7.7%) used game-based applications, and 2 (15.4%) used short message service (SMS)–based health education. Additionally, 1 (7.7%) used video conferencing, and 1 (7.7%) combined SMS and mobile applications. None of the studies employed advanced technologies such as artificial intelligence or robotics. The primary aim of these digital interventions was to provide health education, improve control and management of chemotherapy symptoms and complications, enhance mental health by reducing anxiety, and increase adherence to treatment.

Effects of digital intervention on patients' adherence to chemotherapy

All 13 included studies utilized digital interventions to improve chemotherapy adherence. Two studies did not include control groups. Chemotherapy adherence was monitored using electronic pill monitoring systems like the WisePill device, which recorded medication adherence over 12 months. One application, e-OncoSalud, was specifically designed to promote home-based pharmacotherapy follow-up and ensure the safety of patients receiving oral chemotherapy.

Based on the systematic review results, mobile applications typically included features such as an agenda (doctor's appointments, lab tests, medication schedules), customizable reminders, symptom management tips, a communication menu for contacting healthcare providers, and a general progress tracking menu (for monitoring blood pressure, body temperature, body weight, and side effects).

Short message interventions provided reminders and information on physical activity, nutrition, social and emotional well-being, treatment adherence, and side effect management. Messages focused on initiation, continuation, and adherence to prescribed dosages. Weekly reminders encouraged patients to use web-based applications for reporting symptoms and adherence. Some interventions also included video and audio messages about treatment education, as well as video conferencing for consultations. Digital interventions, including mobile games, used features like multiplayer modes, social networking, and real-life activity encouragement (e.g., exercise, cooking, playing games), while also promoting self-assessment.

DISCUSSION

Given the growing trend of technology use worldwide, digital interventions can make a significant contribution to the provision of high-quality healthcare and health promotion [27]. Digital interventions can significantly improve chemotherapy adherence because of real-time monitoring, patient engagement, personalized support, accessibility and convenience, data-driven insights, and emotional and social support. Digital tools can monitor patients' medication adherence in real-time, providing immediate feedback or reminders. This helps ensure that patients take their medications as prescribed, reducing the chances of missed doses [28][29].

Interactive digital platforms can engage patients more deeply in their treatment process. By providing education, symptom tracking, and direct communication with healthcare providers, patients feel more involved and informed, which can boost adherence [30][31]. Digital tools are often accessible via smartphones or other personal devices, making it easy for patients to integrate them into their daily routines. This convenience helps patients stay on track with their chemotherapy regimen [32]. Digital tools are often accessible via smartphones or other personal devices, making it easy for patients to integrate them into their daily routines. This convenience helps patients stay on track with their chemotherapy regimen[33]. Digital interventions can collect and analyze data on patient behavior, providing healthcare providers with insights into adherence patterns. This allows for early identification of non-adherence issues and timely intervention to address them [34]. Some digital interventions include features like peer support groups, chatbots, or virtual counseling, which can provide emotional support. This support can reduce the psychological burden of chemotherapy, improving adherence [35][33].

In line with the results of this study, Magalhães et al. conducted a systematic review to evaluate the effects of mobile interventions in cancer patients. The results of this study indicate that mobile technology interventions have helped improve chemotherapy adherence in cancer patients [36]. Automatic symptom monitoring via mobile health, along with effective guidance, is an effective intervention in the treatment of cancer and various related symptoms [37]. Promoting the efficient use of this technology will improve treatment-related outcomes and patient experience [38]. Previous research suggests that patients' medication adherence is related to their knowledge of medications and their side effects [39].

The use of technology in cancer patients undergoing chemotherapy improves the patient experience and their active participation in the care process [40]. Additionally, this technology gives patients the opportunity to express their problems and concerns by facilitating communication between the patient and the care team. In addition, the team of symptom-monitoring assistants provides patients with a sense of security [41].

LIMITATION

One limitation of this study is the heterogeneity of the included studies, which

employed different methods to measure the outcomes of digital interventions.

CONCLUSION

This review demonstrates that digital interventions offer a new approach to improving chemotherapy adherence in cancer patients. Technology enables patients to actively participate in their treatment and communicate easily with healthcare providers regarding side effects during chemotherapy. Further research is needed to develop customizable applications or platforms that account for individual patient conditions, cancer types, and chemotherapy schedules, while also considering emotional aspects like mental support through personalized motivational messages.

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