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Application and Website Development as an Effort to Improve Oral Chemotherapy Adherence in Cancer Patients: A Literature Study

Ni Made Juniari[1], I Wayan Sukawana[1], I Made Sukarja[1], Ni Luh Ketut Suardani[1]

[1]Poltekkes Kemenkes Denpasar

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ABSTRACT

The most common adherence problem with oral chemotherapy is forgetting and getting bored with taking medication, which increases mortality and morbidity in cancer patients. Patients forget to take their medication due to busy daily activities and ineffective reminder systems. Patient knowledge about oral chemotherapy also influences chemotherapy adherence. Therefore, it is necessary to develop an educational application with medication reminders. The purpose of this study was to conduct a literature review on application and website development as an effort to improve chemotherapy adherence in cancer patients. This research design is a literature study. This literature search uses articles in English and Indonesian from 5 databases from 2019 to 2024. Articles included in the literature study were critically appraised using the Mixed Methods Appraisal Tools (MMAT) for mixed method research and the Critical Appraisal Skills Programme (CASP) for articles with research designs other than mixed methods. The literature search yielded 10 articles that met the established PICOS framework. Medication reminder apps are crucial for patients undergoing oral chemotherapy because they help patients accurately remember their medication schedules, reducing the risk of missed doses or irregular medication intake. Educational features that should be included in the app include: education on oral chemotherapy and management of chemotherapy side effects. Medication reminders will help patients avoid missing doses, ensuring effective therapy. Education will increase patient knowledge about oral chemotherapy and practical home management of side effects.

Keywords: cancer, oral chemotherpy, adherence, mobile application

Corresponding author: juniarinimade0@gmail.com

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INTRODUCTION

Patients receiving oral chemotherapy often face compliance issues (Rosenberg et al., 2020). The most common factors affecting adherence are forgetting to take medication and becoming bored with the routine (Talens et al., 2021). Patients may forget doses due to busy routines, lack of effective reminders, and complex multi-dose regimens with different rules, which cause confusion about timing and dosage (Liu et al., 2022).

Because chemotherapy is administered in several cycles, the treatment is lengthy. The length of the cycles reflects the severity of the cancer in the patient. Chemotherapy is administered not only parenterally but also orally (Koper et al., 2023). Oral chemotherapy administration is increasing and changing the treatment paradigm in oncology (Magalhães et al., 2020). Self-administration of oral cytotoxics at home places greater responsibility on patients and caregivers than parenteral chemotherapy administered in a healthcare setting. Patients and families struggle with adherence to regimens and managing side effects. Similarly, nurses face challenges in ensuring patient adherence and appropriate management of drug toxicity (Lalithabai et al., 2024). Conventional techniques such as lectures are thought to be less helpful in resolving noncompliance with medication in terms of disease education, side effect control, and reminders to take it (Saha et al., 2021).

According to the World Health Organization (WHO), the three most prevalent types of cancer in 2020 were breast cancer (2.26 million cases), lung cancer (2.21 million new cases), and colorectal cancer (1.93 million new cases). Other cancers in the top five most prevalent include cervical and oral cancer. In terms of cancer deaths, breast, lung, and cervical cancer have the highest incidence and mortality rates (WHO, 2020). This is also relevant in Indonesia, where cancer is a rather common medical problem. According to the Global Cancer Observatory (GLOBOCAN), the number of new cancer cases in Indonesia increased from 396,914 in 2020 to 408,661 by 2022. The most frequent malignancies in Indonesia in 2022 were breast, lung, and cervical cancer (GLOBOCAN, 2024). Chemotherapy adherence rates vary depending on the patient's condition and other factors. Previous research revealed that 40 responders (97.6%) did not comply with chemotherapy (Prastiwi et al., 2022). According to other studies, 9.2% of cancer patients adhered to chemotherapy poorly, 48.7% adhered moderately, and 42.1% adhered strongly (Wulandari et al., 2022).

Corresponding author: juniarinimade0@gmail.com

Chemotherapy can be administered not only as a neoadjuvant and adjuvant therapy, but also as the primary treatment for inoperable cancer or cancer that has spread to other tissues or organs (D'Alterio et al. 2020). Most cancer patients received adjuvant chemotherapy. This chemotherapy is intended to eliminate any remaining cancer cells in the body, slow the spread of disease, and improve patient recovery (Saini et al., 2020). Non-compliance with oral chemotherapy may lead to a variety of consequences, including treatment failure, which prevents evaluation of its effectiveness, increased morbidity and mortality, and a high likelihood of switching to parenteral regimens, which can be even more stressful for patients (Jacobs et al., 2019).

Advances in technology and information in healthcare can be leveraged for a holistic nursing model. This holistic nursing model focuses on patient-response-based interventions that promote holistic healing and increase patient awareness of their own health (Younas, 2020). Digital technology applications can be maximized when healthcare professionals empower patients, thereby improving the quality of patient care (Ross et al., 2019). One example of technology utilization in healthcare is the development of web and mobile applications.

Previous research built an instructional application regarding oral chemotherapy that included a menu for reporting reported adverse effects but lacked a reminder function. Although patient compliance increased, there was no substantial increase in adherence (Karaaslan-Eser & Ayaz-Alkaya, 2021). Previous research has also involved the developmeedication schedules.nt of mobile phone-based applications. This study created a reminder tool; however, it has not been effectively used to evaluate chemotherapy adherence in patients on interval dose schedules. The developed application only employs reminders and does not include a medication calendar, making it difficult for patients with interval dosing to keep track of their medications (Greer et al., 2020). Previous research has also involved the development of medication schedules. Other studies have also used text messaging (SMS) to manage chemotherapy adverse effects. One limitation of earlier studies is that the treatments gave just textual advice on chemotherapy side effects management, rather than audiovisual media. Patients were also unable to send reply messages in response to messages (Rico et al., 2020). These studies found no link between technology use and increased adherence to oral

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chemotherapy. The goal of this study is to conduct a literature review on the development of web and mobile applications to increase adherence to oral chemotherapy medicine in cancer patients.

METHOD

This literature study supports the development of educational applications with reminders as an effort to improve oral chemotherapy adherence in cancer patients. The literature search used the keywords ("mobile app*" OR "smart app*" OR telemedicine OR "mobile health" OR "smartphone app*" OR telehealth) AND ("chemotherapy adherence" OR "chemotherapy compliance" OR adherence OR compliance) AND ("oral chemotherapy" OR "oral anticancer agent"). English and Indonesian articles published from 2019 to 2024 were sourced from Scopus, PubMed, Web of Science (WoS), ProQuest, and CINAHL. The included studies were critically appraised using the Mixed Methods Appraisal Tools (MMAT) for mixed-methods research and the Critical Appraisal Skills Programme (CASP) for other study designs.

Table 1. Article Search for Literature Study

PICOS Framework	Inclusion Criteria	Exclusion Criteria
Population	The study focused on cancer patients receiving oral chemotherapy.	Cancer patients who do not receive oral chemotherapy
Intervention	Web and mobile application	Conventional health education
Comparators	No comparator	No exclusion criteria
Outcomes	Oral chemotherapy adherence	No exclusion criteria
Publication year	2019-2024	Before 2019
Study design	Randomized control trial (RCT), quasy experiment, pilot study, feasibility study, observasional study	
Language	English	Others

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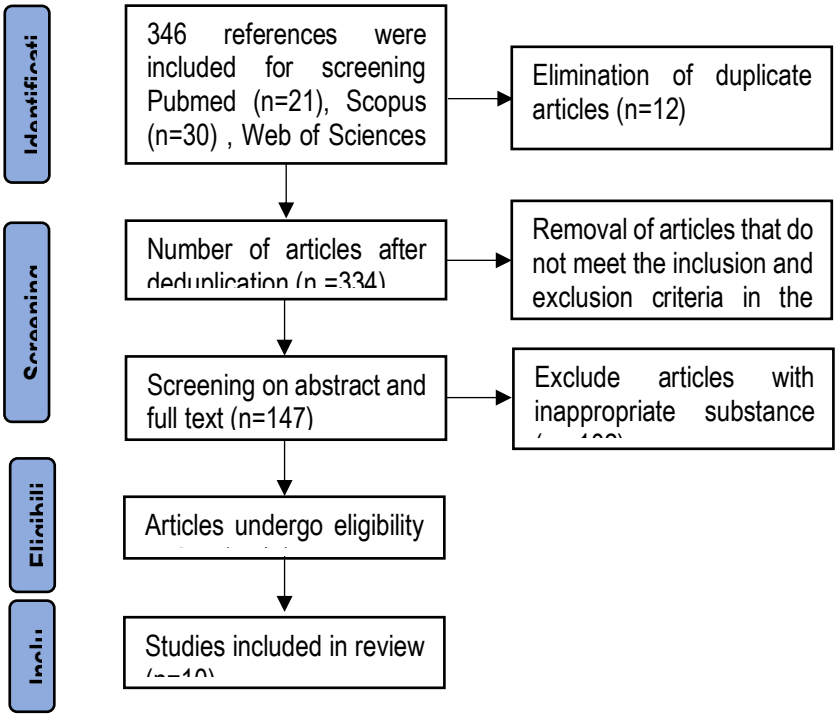
Picture 1. Literature Screening Flowchart



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RESULTS

Author conducted a critical appraisal to identify research bias; studies scoring 75% or higher met the inclusion criteria. The findings from the literature review are as follows:

No	Tittle	Method	Results
1	Co-Design, Development, and Evaluation of a Mobile Solution to Improve Medication Adherence in Cancer: Design Science Research Approach (Dang et al., 2024)	The Safety and Adherence to Medication and Self-Care Advice in Oncology (SAMSON) application includes patient profiles, medication reminders, side effect assessment and management, reinforcement, and reporting. Respondents used the SAMSON application for at least 6 weeks before completing a questionnaire to assess its quality.	Most respondents found the SAMSON app engaging and well-organized. They also found the app informative and able to enhance user interaction with caregivers. Most respondents also felt that the activities within the SAMSON app could help improve their adherence to cancer treatment. More than half (63%) stated that they would recommend the app to their friends.
2	SoBat Kanker smartphone application to improve oral chemotherapy adherence among cancer patients in Indonesia: Development, usability, and	The SoBat Kanker app features a list of patient medications, alarm reminders, medication information, and reminders for upcoming visits. This study consisted of two phases: the first phase focused on developing the app using a user-centered	The results of the first phase of the study showed that the SoBat Kanker application had an excellent level of usability, with an average SUS score of 85.33, indicating that this application has an A grade and is well accepted by users. Furthermore, preliminary results from adherence measurements showed

Corresponding author: juniarinimade0@gmail.com

No	Tittle	Method	Results
	feasibility pilot study (Puspitasari et al., 2024)	design approach and evaluating it using the System Usability Scale (SUS), while the second phase focused on testing the app's feasibility using a single-group pre-post-test design. In the first phase of the study, participants were given the SoBat Kanker app for a period of 6 weeks. During this period, patients used the app to support their adherence to oral chemotherapy.	a significant increase in patient compliance after using the application, with a p-value < 0.001 at the six-week follow-up.
3	A Smartphone-Based App to Improve Adjuvant Treatment Adherence to Multidisciplinary Decisions in Patients With Early-Stage Breast Cancer: Observational Study (Yu et al., 2021)	This study used a full course of treatment application. Patients can access the application through app distribution platforms, such as the Google Play Store for Android devices or the Apple App Store for iOS devices. The application is designed to be installed on the patient's smartphone.	This study found that patients who used the app had higher adherence to adjuvant treatment compared to patients who did not use the app. Adherence to chemotherapy was independently associated with app use, suggesting that the app may serve as an effective intervention to improve patient adherence.
4	Digital remote monitoring plus usual care versus	The Cancer Treated Using Oral Therapeutics (CAPRI) program can	There were fewer patients with low adherence in the CAPRI

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No	Tittle	Method	Results
	usual care in patients treated with oral anticancer agents: the randomized phase 3 CAPRI trial (Mir et al., 2022)	improve adherence to oral chemotherapy through several methods, including: medication reminder features, education about therapy and side effects, and features that enable interaction between patients and nurses.	group compared with the group receiving usual care.
5	Randomized Trial of a Smartphone Mobile App to Improve Symptoms and Adherence to Oral Therapy for Cancer (Greer et al., 2020)	Patients were given a trial of the app for one treatment cycle. The app includes a medication schedule feature and an educational menu for symptom management.	The average adherence score in patients given the mobile app was higher than in the group receiving only usual care. The use of mobile apps can be used to monitor patient adherence to oral chemotherapy.
6	The effect of a mobile application on treatment adherence and symptom management in patients using oral anticancer agents: A randomized controlled trial (Karaaslan-Eser & Ayaz-Alkaya, 2021)	Patients receiving oral chemotherapy receive the Oral Chemotherapy Treatment and Education Device (OKTED) app for six months. Features of the app include oral anticancer education, a calendar for recording treatment start/end dates, medication reminders, symptom management, and support contacts.	The use of the OKTED app significantly improved oral chemotherapy adherence scores in the intervention group compared to the control group. This indicates that this mobile app is effective in improving chemotherapy adherence in patients using oral anticancer agents. Ninety percent of patients who used the app recommended it to others, indicating a high level of satisfaction with the app.

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No	Tittle	Method	Results
7	Novel Tool to Monitor Adherence to Oral Oncolytics: A Pilot Study (Sun et al., 2021)	This research developed a platform called Nomi to monitor adherence to oral chemotherapy in cancer patients. If a cellular connection is available, information about medication intake is automatically entered into the Nomi platform. The platform can send reminders via text message to patients if a dose is missed or not taken according to schedule. Patients are monitored using the Nomi system for at least one cycle of capecitabine.	Although most patients were already compliant from the start, the study results showed improved adherence after receiving reminders. Oral chemotherapy adherence increased from 72% to 89% after reminders were sent.
8	Cancer patients' perceived value of a smartphone app to enhance the safety of home-based chemotherapy: Feasibility study (Kongshaug et al., 2021)	The smartphone application developed includes several features designed to improve patient adherence to treatment, provide a sense of security, and facilitate communication between patients and healthcare providers. These features include education, medication reminders, side	The study results showed that patients found the medication reminder feature a useful tool and believed it improved their adherence to treatment. Using the app helped patients learn more about their medications and potential side effects, contributing to a better understanding of their condition and the treatment they were taking.

Corresponding author: juniarinimade0@gmail.com

No	Tittle	Method	Results
		effect reporting, a medication calendar, and a system that allows patients to contact nurses at the cancer clinic if they need assistance or have questions about their treatment. Respondents in this study used the application for 2-3 weeks, or one chemotherapy cycle.	
9	Effect of a Mobile App for the Pharmacotherapeutic Follow-Up of Patients with Cancer on Their Health Outcomes: Quasi-Experimental Study (Collado-Borrell et al., 2020)	Patients use the e-Oncoslaud app during their chemotherapy cycles. They can set their own medication reminders within the app. Patients can log their symptoms and side effects through the app. They can report these in real time, and the app will provide recommendations based on the data entered. The app provides a messaging menu that allows patients to communicate directly with pharmacists or other healthcare professionals. Patients can ask questions,	Patients use the e-Oncoslaud app during their chemotherapy cycles. They can set their own medication reminders within the app. Patients can log their symptoms and side effects through the app. They can report these in real time, and the app will provide recommendations based on the data entered. The app provides a messaging menu that allows patients to communicate directly with pharmacists or other healthcare professionals. Patients can ask questions, report side effects, or request clarification about their treatment.

Corresponding author: juniarinimade0@gmail.com

No	Tittle	Method	Results
		report side effects, or request clarification about their treatment.	
10	Oral medication adherence among adolescents and young adults with cancer before and following use of a smartphone-based medication reminder app (Lauri A. Linder et al., 2019)	Respondents were asked to use the Dosecast Pro app during the 8-week intervention period. The app allows participants to set medication reminders and track their adherence. The app also includes education about the importance of medication adherence, side effects, and how to manage them.	The most common reason respondents cited for non-adherence to their medication was forgetfulness. This app provides regular, customizable reminders to help patients remember when and how to take their medication. This is particularly helpful for patients who experience forgetfulness, which was the primary reason for non-adherence in this study. The app includes educational information about the importance of medication adherence, side effects, and how to manage them. Improved knowledge can increase patients' motivation to adhere to their medication. The reminder app provides rewards for patient adherence, which can motivate them to stay compliant.

Literature studies have shown that medication reminder applications are crucial for patients undergoing oral chemotherapy because they help patients accurately remember their medication schedules, reducing the risk of missed doses or irregular medication intake (Dang et al., 2024) (Karaaslan-Eser & Ayaz-Alkaya, 2021) (Puspitasari et al., 2024) (Mir et al., 2022) (Collado-Borrell et al., 2020). Oral chemotherapy must be taken regularly and on time to

Corresponding author: juniarinimade0@gmail.com

maintain treatment effectiveness. The success of cancer therapy, including oral chemotherapy, depends heavily on consistency and accuracy in adhering to the medication schedule (Karaaslan-Eser & Ayaz-Alkaya, 2021) (Kongshaug et al., 2021). Application assistance helps patients better adhere to their medication regimen, which contributes to better treatment outcomes.This section presents the results that have been processed based on the type of research used. This section presents the data presented in tables and diagrams and their interpretations clearly. The interpretation in the results section is not just reading out the data that has been obtained, but the data obtained is interpreted clearly and precisely accordingly (Puspitasari et al., 2024) (Dang et al., 2022) (Yu et al., 2021) (Mir et al., 2022) (Greer et al., 2020) (Kongshaug et al., 2021) (L A Linder et al., 2019).

Education through mobile applications for cancer patients receiving oral chemotherapy has several important benefits, which can support them in undergoing treatment better and more effectively (Yu et al., 2021) (Greer et al., 2020). Mobile applications allow patients to obtain information about treatment, side effects, and self-care steps anytime and anywhere (Dang et al., 2024) (Puspitasari et al., 2024) (Mir et al., 2022) (Greer et al., 2020). Patients do not need to always rely on doctor visits to obtain the necessary knowledge (Karaaslan-Eser & Ayaz-Alkaya, 2021) (Kongshaug et al., 2021) (Collado-Borrell et al., 2020). Well-educated patients tend to be more compliant with treatment. Apps that provide educational content, such as videos, articles, and infographics, can help patients understand the importance of taking medication on time and following instructions correctly, ultimately improving treatment outcomes (Greer et al., 2020) (Karaaslan-Eser & Ayaz-Alkaya, 2021) (Kongshaug et al., 2021).

Educational features that should be included in the application include: education about oral chemotherapy and chemotherapy side effect management. Disease and treatment education provides clear information about the type of cancer the patient has, how to use oral chemotherapy drugs, and the goals of therapy (Mir et al., 2022) (Greer et al., 2020) (Karaaslan-Eser & Ayaz-Alkaya, 2021) (L A Linder et al., 2019). Education about side effect management provides patients with practical information on how to better manage these symptoms, whether through lifestyle changes, diet, or additional medications (Dang et al., 2022) (Greer et al., 2020) (Kongshaug et al., 2021). This helps patients stay comfortable and able to undergo treatment with fewer obstacles. Complete information about the disease, treatment, and potential side

Corresponding author: juniarinimade0@gmail.com

effects allows patients to make better decisions regarding their health management. For example, patients will better understand when to contact a doctor immediately or when it is sufficient to manage side effects at home (Greer et al., 2020) (Kongshaug et al., 2021).

Literature studies indicate that before using an application to assess patient compliance, a feasibility test can be conducted for 2-3 weeks or one cycle of chemotherapy (Greer et al., 2020) (Sun et al., 2021) (Kongshaug et al., 2021). Applications that have passed the feasibility stage can be used to assess compliance with oral chemotherapy, with intervention durations varying from 6 weeks, 8 weeks, to 6 months (Dang et al., 2022) (Puspitasari et al., 2024) (Karaaslan-Eser & Ayaz-Alkaya, 2021) (L A Linder et al., 2019).

DISCUSSION

A literature review was conducted in this study, finding 10 articles relevant to the development of web-based and mobile applications. All reviewed articles have undergone a critical appraisal process so that the quality of the articles can be trusted. These articles discuss how to ensure an application is effective and meets patient needs. All articles describe the development of digital applications targeting cancer patients receiving oral chemotherapy. Features that are not yet available in the web or mobile application include: a medication calendar has not been developed for adherence monitoring, an admin account has not been explained, and the role of nurses in using the application has not been fully described. Several things that need to be considered in application development include: the importance of oral chemotherapy adherence, the development of a user-centered application design, educational content, a reminder system, the feasibility or acceptability of the application, and its integration with healthcare providers.

Medication adherence in oral chemotherapy programs plays a crucial role, as non-adherence can lead to poor treatment outcomes and increased healthcare costs. One study showed that adherence rates to oral chemotherapy can vary significantly, often falling between 50% and 70% (Puspitasari et al., 2024). These results highlight the need for effective interventions to address this issue.

A study showed that developing an app with medication reminders can significantly help patients remember to take their medications. Research shows that reminders, whether via

Corresponding author: juniarinimade0@gmail.com

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SMS or app notifications, can encourage patients to take their oral chemotherapy drugs on time (Skrabal Ross et al., 2022). Reminder apps can reduce non-adherence issues by providing timely reminders (Liu et al., 2022). Apps can be supplemented with educational materials about medications, their side effects, and the importance of adherence. This can empower patients with knowledge and improve their adherence to treatment (Gönderen Çakmak & Kapucu, 2021). App design should prioritize user experience, ensuring patient accessibility. Features that allow patients to customize medication schedules and reminders independently can increase user engagement (Wu et al., 2019).

The app should provide comprehensive educational materials about oral chemotherapy, including drug information such as dosage and administration. Information about side effects and side effect management is equally important, as it can help patients manage their symptoms independently at home (Hartch et al., 2024). The reminder system uses visual and audible notifications to remind patients when to take their medication. Implementing a feature that allows patients to confirm medication intake data can be used by nurses to assess adherence (Wu et al., 2019). Developed apps should solicit user feedback regarding their experiences with the app for future improvements. App development should facilitate communication between patients and healthcare providers. One form of this communication is allowing healthcare providers to access adherence data to help monitor patient progress and intervene when necessary (Hartch et al., 2024).

Author believe that a literature review can provide a comprehensive overview of the considerations needed to develop an educational app with an effective reminder system. A health education app with medication reminders can significantly improve oral chemotherapy adherence by addressing forgetfulness, increasing patient knowledge, and providing symptom management resources. The app can also facilitate better monitoring and personalized interventions, ultimately supporting patients in adhering to their treatment regimen.

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CONCLUSIONS

Based on the results, it can be concluded that the recommendations from the literature review have proven the need to develop an application with reminders to improve adherence to oral chemotherapy in cancer patients. Medication reminders will ensure patients do not miss medication, ensuring effective therapy. Education increases patient knowledge about oral chemotherapy and practical home management of side effects. This increased knowledge also increases patient confidence in treatment.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Corresponding author: juniarinimade0@gmail.com

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Corresponding author: juniarinimade0@gmail.com