RESEARCH ARTICLE

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Check the Impact of Mobile Health on Medication Adherence in Adolescents with Leukemia

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Abstract

Introduction: Leukemia is considered one of the most common childhood cancers, requiring long-term treatment that often affects adherence to the treatment. Treatment adherence is one of the most important health issues. Adolescents demonstrate the highest scores of non-adherences to treatment. Treatment adherence refers to the extent to which a patient follows medication protocols, dietary guidelines, and lifestyle adjustments as per healthcare provider recommendations. Mobile health programs utilize mobile technology to provide health services. Given the potential influence of mobile technology interventions on treatment outcomes, a study was conducted to assess the impact of mobile health on medication adherence in adolescents with leukemia. **Methods:** This study, a clinical trial conducted in 2023, involved the selection of sixty adolescents meeting entry criteria, who were then randomly allocated to intervention (30 participants) and control groups (30 participants). The intervention group utilized a treatment adherence application for eight weeks. Data collection utilized the Morisky Medication Adherence Questionnaire and the Mobile Application Rating Scale (MARS). **Results:** There were no significant demographic differences between the intervention and control groups. Pre-test results showed a mean adherence score of 6.000 with a standard deviation of 1.11 in the intervention group and 4.25 with a standard deviation of 1.45 in the control group, with no statistically significant variance. Post-test results indicated increased treatment adherence in the intervention group, while no change was observed in the control group. **Conclusion:** The use of a mobile health application enhances treatment adherence among adolescents with leukemia.

Keywords: Treatment adherence- Leukemia- Adolescents- Mobile Health

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Introduction

Among childhood cancers, leukemia is the most common malignancy in childhood .[1] Leukemia is a chronic disease with a prolonged treatment period that significantly impacts human health and quality of life. The extended treatment duration often challenges treatment adherence [2, 3]. Treatment adherence in chronic diseases is one of the most important health problems [4].The mean adherence score in developed countries is around 50%, and in developing countries, this score is even lower [5].

Adherence is a multidimensional behavior influenced by various factors such as patient-related, social, economic, healthcare system-related, disease-related, and treatment-related factors [4]. Treatment adherence refers to the extent to which a patient follows medication protocols, dietary guidelines, and lifestyle adjustments as per healthcare provider recommendations [6]. Non-adherence to medication protocols refers to the degree of non-compliance with health or treatment recommendations [7].

The age factor plays a significant role in treatment adherence behavior in children with cancer. Studies have shown that adolescents have the highest score of non-adherence to treatment [8].Adolescence is a transitional phase between childhood and adulthood [8, 9]. During this period, factors such as peer influence, self-image concerns, independence aspirations, and occasional forgetfulness can lead to non-adherence to treatment and medication regimens in teenagers [10]. Failure to adhere to medication treatment leads to disease progression, increased side effects, reduced quality of life, disease recurrence, increased treatment costs, and higher hospitalization rates [11]. It appears that the use of social media and mobile phone technology can be helpful [12].

Mobile health is the use of mobile technology in providing healthcare services [13] and is a new research

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field aimed at facilitating access to health services, remote health monitoring, and enhancing patient experiences [14-16] .Mobile health applications using features such as medication reminders, facilitating disease symptom monitoring and self-control, increasing access to information, and utilizing educational tools for patients, on the one hand, enable more efficient staff planning and, on the other hand, provide cost savings [17].

Since the most common form of non-adherence to treatment in the adolescent patient population is non-adherence to medication [18], nurses play a crucial role in treatment adherence through education to parents and adolescents and their social and psychological support [7]. Additionally, given the high prevalence of leukemia among children and adolescents and the importance of completing the treatment course to control the disease, there is a need for regular follow-ups by the care team, especially nurses, and the use of emerging communication technologies and mobile health technologies to improve treatment adherence in this patient group. Therefore, due to the lack of such research in Iran, the study was conducted to determine the impact of a mobile health program on medication treatment adherence in adolescents with leukemia.

Materials and Methods

This study is a clinical trial conducted at selected hospitals in Tehran. The study population comprised adolescents aged 10 to 21 diagnosed with leukemia who were attending designated hospitals in Tehran. Inclusion criteria involved being able to read and write in Persian, having access to a smartphone, not having any other diseases besides leukemia, and having no history of participation in similar educational classes or programs. Exit criteria included adolescent mortality, failure to complete the questionnaire, non-use of the application, and any incident leading to deterioration in the adolescent's condition preventing further participation. Sampling was done using a simple random method. A sample size of 70 individuals was estimated using the sample size formula and randomly allocated to either the control or intervention group.

Research Instrument

The research utilized a questionnaire on demographic information and clinical records, the Morisky et al. Adherence to Treatment Questionnaire, and the Mobile Application Rating Scale for data collection. The questionnaire on demographic information and clinical records for patients included data such as age, gender, educational level, occupation, family size, economic status, and disease-related information, including the disease stage. The demographic information questionnaire was developed by the research team.

The Morisky et al. Adherence to Treatment Questionnaire was designed and formulated in 2008 to evaluate adherence to medication treatment. It consists of seven binary questions (with yes or no responses) and one Likert-scale question, with question five being scored in the opposite direction compared to the other questions. The overall score range is from zero to eight. Lower scores indicate higher medication adherence [19].

The MARS scale was developed by Stoyan et al. in 2016 to assess the quality of mobile applications. MARS consists of two components: objective and subjective. The objective component includes 19 questions divided into four sections: engagement, functionality, aesthetics, and information quality [20].

Data Collection

After sampling and obtaining informed consent (for adolescents under 18 years old, consent was obtained from parents and legal guardians), comprehensive explanations about the research and its objectives were provided to the adolescents and completed. In the same session, the researcher's contact information was shared with the adolescents, and their contact information was obtained for research coordination, forming a group chat on an Iranian messenger, "Baleh".

After the random allocation of research samples, an in-person session was held to instruct parents and adolescents on how to install and use the application. All questions were answered. Finally, the application was installed and operated by the adolescents themselves on their mobile phones. The present application was designed by the researcher in collaboration with a team of specialized designers in this field. After the research team approved its functionality and applicability, the application was implemented. This Android-compatible app offers features such as updates (e.g., adjusting the volume of alerts, selecting alert types, setting alarms based on dates, and adding games to encourage adolescent engagement) and can be installed on both mobile phones and tablets. Currently, it is being used by adolescents with leukemia, but given its general design, it is also suitable for other age groups and medical conditions.

The second measurement took place after the intervention (eight weeks later), involving both intervention groups (those with access to the application) and the control group (receiving routine care only). The Morisky et al. Adherence to Treatment Questionnaire was completed by both groups, while the MARS questionnaire was completed by the intervention group. In case of no physical visit, the research tools were administered in the "Baleh" group chat.

The intervention in this study involved using the application, which includes four sections: setting alerts, recording medication reports, educational content, and messaging. In this application, users can record medication consumption times and patterns along with dates. To record medication adherence, users are prompted with the question, "Did you take this medication as scheduled?" after clicking on their set medication reminder, the user must respond with "Yes" or "No." The response, along with the date, is recorded on a chart. By clicking on the circular icon, information regarding medication adherence or non-adherence is displayed on a pie chart, where blue indicates medication adherence, and red indicates non-adherence.

Additionally, users can access information related to cancer, risk factors, and chemotherapy care. The

Table 1. Frequency Distribution of some Demographic Variables of Research Units in the Intervention and Control Groups

	Variables	Intervention Group		Control Group		P-Value
		F	%	F	%	0.58
Gender	Female	16	45.7	19	54.3	
	Male	19	54.3	16	45.7	
Level of Education	Lower Secondary School	22	62.9	21	60	0.59
	Upper Secondary School	13	37.1	14	40	
Number of Siblings	1	7	20	6	17.1	0.41
	2	24	68.6	25	71.4	
	3	4	11.4	4	11.4	

application also allows for messaging, enabling users to communicate with the researcher, share test results, ask questions, and resolve any uncertainties by sending photos. During this period, users were asked weekly about their experience using the application. If a user did not send a message in the app's messaging section after two weeks, they were contacted via phone call or through the internal messaging platform, "Baleh." In case of any issues with the application, the researcher informed the designer and developer to resolve the problem.

Descriptive and inferential statistical methods were used for data analysis, conducted using SPSS version 19. All ethical requirements of this research were reviewed by the Medical Ethics Committee of Shahid Beheshti University of Medical Sciences, approved with the ethical code IR.SBMU.PHARMACY.REC.14.20.43 and clinical trial code IRCT20161024030474N7.

Results

The frequency distribution of certain demographic characteristics in the intervention and control groups is presented in Table 1. In the intervention group, 45% of participants were female and 54% were male, while in the control group, 54% were male and 45% were female. Table 1 displays some demographic characteristics of the adolescents participating in the study. The results indicated that there was no significant difference in these characteristics between the two groups ($p > 0.05$).

Adherence to medication treatment in the intervention and control groups was assessed before and after the intervention. Based on the results of the analysis of covariance to examine the impact of mobile health on medication adherence in adolescents with leukemia, the adherence score in the intervention group differed significantly from the control group ($p < 0.05$). Therefore, it can be concluded that patients in the intervention group, utilizing mobile health and the application, exhibited greater adherence to medication in comparison to their counterparts. The study's effect size, determined through covariance analysis, was found to be 0.425, signifying the effectiveness of the intervention in enhancing medication adherence (Table 2).

The quality of the content in the remote monitoring program from the perspective of adolescents with leukemia is presented in Table 3. The quality score of the application is different in different dimensions, and the attractiveness dimension has a higher score compared to other dimensions.

Discussion

This study aimed to investigate the impact of mobile

Table 2. Comparison of Treatment Adherence Regimen in the Intervention and Control Groups, before and after the Intervention

Time/ Group	Number	Before the intervention Mean ± SD	After the intervention Mean ± SD	P-value*
Intervention	35	6 ± 1.11	2.25 ± 1.19	0.001 ***
Control	35	4.25 ± 1.45	3.25 ± 1.43	0.001 ***
P-value*		0.07*	0.001**	

*, Independent Sample T-Test; **, Analysis of Covariance (ANCOVA); ***, Paired Samples T-Test

Table 3. Mobile Application Rating Scale from Users' Perspective after Intervention

Program Quality Dimensions		Number	Mean ± SD
Objective Dimension	Engagement	35	5.61 ± 0.96
	Functionality	35	5.17 ± 0.89
	Aesthetics	35	3.74 ± 0.85
	Information	35	4.04 ± 1.06
Subjective Dimension		35	4.42 ± 1.50
Total Score			4.59 ± 5.26

health programs on treatment adherence in adolescents with leukemia. The results of the present study showed that the use of mobile health programs leads to an improvement in treatment adherence in adolescents with leukemia ($P<0.05$). Treatment adherence in children with chronic diseases is a crucial and very important issue that is difficult to achieve [21, 22].

The mean treatment adherence score before intervention in the intervention group was 6, and in the control group was 4.25. According to statistical analysis, this difference was not significant, and the treatment adherence score in adolescents with leukemia in both groups was reported to be low before the intervention in the present study ($P=0.07$).

Some studies have also reported low medication adherence scores, consistent with the findings of the present study, where medication adherence in adolescents with cancer has been reported to be low. A study conducted in 2020 titled "The Impact of Daily Text Messaging and Directly Supervised Therapy on Adherence to Oral Mercaptopurine in Children with Acute Lymphoblastic Leukemia" showed that medication adherence in children was low before the intervention, but increased after the telephone intervention ($P=0.04$) [2].A study conducted in 2020 on adolescents with asthma showed that factors such as independence, fear of medication addiction, stigma, and lack of trust in the healthcare system decrease treatment adherence, leading to worsening of the disease, increased hospitalization duration, and reduced quality of life [23].

However, there are conflicting results with the present study. Silva et al. conducted a study in 2022 to assess treatment adherence in adolescents and children recently diagnosed with juvenile rheumatoid arthritis. Contrary to the results of the present study, medication adherence scores were high in adolescents in this study. This discrepancy may be due to the high sensitivity and concern at the initial stage of diagnosing the disease, resulting in high medication adherence scores in adolescents at the early stages of juvenile rheumatoid arthritis diagnosis, whereas in the present study, all stages of the disease were considered, and adolescents were evaluated in all stages of the disease (except the end stage of life) [24]. According to Morisky et al.'s questionnaire, the lower the score obtained, the higher the treatment adherence. In the current study, the mean medication adherence score in the intervention group was 6 before the intervention and increased to 2.25 after the intervention, indicating an increase in treatment adherence. The mean medication adherence score in both groups before the intervention did not show a significant difference ($P = 0.07$), but after the intervention, the medication adherence score in the intervention group significantly increased ($P=0.001$). This means that the mobile health program was effective in improving medication adherence.

In the present study, the quality and content of the application were evaluated by users after the intervention using the Mars (Mobile application rating scale) questionnaire and calculated using the t-test. According to the statistical analysis performed, attractiveness was assigned a higher score compared to other dimensions. Another study in 2019 by Weisel et al. aimed to evaluate dermatology apps for German-speaking patients, which showed that among the studied apps, two apps scored highest in attractiveness and lowest in information [25]. On the other hand, Omidvari et al. designed an app for use by physicians in 2022, which used a mobile ranking scale for app evaluation, assigning the highest score to beauty and the lowest scores to interaction and information dimensions The results obtained may be because these types of apps require less user interaction compared to apps designed to change and modify user behavior, thus needing less user interaction. Therefore, the information and performance dimensions in this study received the lowest scores [25, 26].

In conclusion, the results of the present study have shown that the use of mobile health programs is effective in improving treatment adherence in adolescents. The medication adherence score of patients increased after using the application, and this type of intervention has been effective in enhancing patients' adherence to their treatment. Implementing this method leads to improved quality of care, reduced hospitalization time, lower treatment costs, and improved quality of life. Therefore, this highlights the importance of paying attention to mobile health methods as an effective factor in improving treatment adherence in adolescents with leukemia and its potential application in other diseases and even other age groups. The use of mobile phone technology and applications was strength of the current study. Treatment adherence has multiple dimensions, but in this study, only one dimension, namely medication adherence, was addressed, which is a limitation of the study. It is therefore recommended to investigate the impact of mobile health programs on all dimensions of treatment adherence in adolescents with leukemia.

Limitations of this study include inadequate cooperation from some selected hospitals for sampling, which resulted in a longer sampling process.

Author Contribution Statement

MH and ASF contributed to the design and implementation of the research, MH and MV designed the app, MN contributed to the analysis of the results and MH and ASF contributed to the writing of the manuscript..

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Availability of data

The data that support the findings of this study are available on request from the corresponding author..

Conflict of Interest

There is no conflicts of interest.

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