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The Role of Mobile Health Applications in Treating Childhood Acute Lymphoblastic Leukemia- A literature review of parental management

A Descriptive Literature Review

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Abstract

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Acute lymphoblastic leukemia is the type of cancer that disrupts the normal function of hematopoietic system, which produces cellular component in blood and bone marrow. The role of mobile health applications in treating childhood acute lymphoblastic leukemia empowers the parental management by providing digital tools for providing better care to their children. Nurses are responsible for educating parents on managing the treatment including symptoms tracking, managing side effects and monitoring the situation outside the hospital setting. Nurses play an essential role in care and treatment of pediatric cancer patients. The purpose of this bachelor's thesis is to describe the parental management in treating childhood acute lymphoblastic leukemia through mobile health applications in pediatric nursing. This thesis aims to improve knowledge about parental management of acute lymphoblastic leukemia treatment through mobile health applications in pediatric nursing.

This thesis employs a descriptive literature review methodology. Selected articles were obtained from reliable databases CINHAL and Medline in addition to manual search. The manual search included articles from Google Scholar and relevant references from other articles. Three articles were sourced from CINHAL, two articles from Medline and two articles from manual search. A Prisma diagram was utilized for collecting and selecting articles, and inductive content analysis was employed to analyze the results and answer the research question.

The results of this thesis indicate a positive impact on parental management in treating childhood acute lymphoblastic leukemia through utilization of mobile health applications during the treatment. mHealth solutions were found to be effective in facilitating communication and management with healthcare professional teams while treating childhood acute lymphoblastic leukemia. Parents reported that mHealth applications served as supportive tool, providing ongoing information conveniently. Parents expressed satisfaction with mHealth solutions, noting that these tools provided supportive and higher-quality care during treatment. The types of mobile health applications identified in the selected studies included Care assistant app, Chemo assist of children app, Smartphone app, WeChat, WhatsApp and another Care assistant app.

Keywords: Acute lymphoblastic leukemia (ALL), children, parental management, mobile health applications, treatment of acute lymphoblastic leukemia

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Akuutti lymfaattinen leukemia on pahanlaatuinen veritauti, joka häiritsee hematopoeettisen järjestelmä normaalia toimintaa, joka puolestaan tuottaa solukomponentteja verta ja luuydintä. Mobiili terveyssovellusten rooli antaa vanhemmille digitaalisia työkaluja, joiden avulla tarjota lapsilleen parempaa ja nopeaa hoitoa. Sairaanhoidtajat toimivat roolimallina syöpälapsipotilaille kuin he kouluttavat vanhempia hoitamaan lapsiaan paremmin. Vanhemmat voivat seurata lasten oireita, haittavaikutusten hallintaa ja tilannetta sairaalan ulkopuolella mobiiliterveyssovellusten avulla. Tämän oppinäytetyön tarkoituksena on kuvata vanhempien johtamista lasten akuutin lymfaattisen leukemian hoitamisessa mobiiliterveyssovelluksilla ja tämän opinnäytetyön tavoitteena on parantaa tietämystä vanhempien mobiilisovellusten käytöstä lasten akuutin lymfaattisen leukemian hoitotyössä.

Aineiston hakuun käytettiin tässä opinnäytetyössä CINHALL- ja Medline tietokantoja sekä manuaalista hakua. Manuaalisella haulla tutkija on hakenut tietoa Google Scholarista ja asiaankuuluvien artikkelien viitteistään. Haku rajattiin määritellyillä sisäänottokriteereillä ja poissulkukriteereillä, joiden perusteella valittiin 7 artikkelia yhteensä. Prismakaaviota on käytetty artikkelien keräämiseen ja valintaan. Aineisto analysoitiin käyttäen induktiivista sisältöanalyysia ja luotiin sisältöanalyysitaulukko, jossa on useita alakategorioita ja kaksi pääkategoriaa, jotka auttavat vastaamaan tutkimuskysymyksiin.

Tämän opinnäytetyön tulokset osoittivat, että vanhemmuuden johdolle mHealth- ratkaisujen hyödyntäminen oli tehokas tapa kommunikoida ja hoitaa terveydenhuollon ammattilaisten kanssa lasten akuuttia lymfaattista leukemiaa. Vanhemmat osoittivat, että mobiiliterveyssovellukset olivat tukena lasten hoidolle ja ilmaisivat että haluavat jatkaa mobiiliterveyssovellusten käyttöä. Mobiiliterveyssovellustyyppinä valituissa tutkimuksissa olivat Care assistant- sovellus, Chemo assist of children, Älypuhelinsovellus, WeChat, Whatsapp-sovellus ja toinen Care assist sovellus.

Avainsanat: Akuutti lymfaattinen leukemia (ALL), lapset, vanhempien hallinta, mobiili terveyssovellukset, akuutti lymfaattinen leukemian hoito

Tämän opinnäytetyön alkuperä on tarkastettu Turnitin Originality Check -ohjelmalla.

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Appendix 1. List of selected studies

1 Introduction

The burgeoning domain of encompassing mobile health applications, mHealth and telehealth services, has emerged as a pivotal innovation in contemporary healthcare. Mobile health applications facilitate expedited and real-time communication between healthcare professionals specifically parents and nurses managing pediatric illnesses such as Acute Lymphoblastic Leukemia (ALL). The importance of these technological advances lies in their ability to enhance the teamwork and improvement treatment planning, which are crucial for improving patient care outcomes (Martinez-Perez et al. 2013: 120.)

The World Health Organization identifies eHealth and mHealth as a crucial and rapidly expanding resources for enhancing healthcare access and quality through the delivery of services. However, there is limited research on their integration into existing healthcare frameworks and compatibility with various socioeconomic groups (Smith, Swallow, and Coyne. 2015: 143-159; World Health Organization.)

In the spectrum of pediatric oncology, the American Cancer Society's statistics, estimate there are 3050 new (ALL) cases in 2022 in the U.S. It underscores the urgency of efficient patient care, further substantiated by the prevalence of leukemia diagnoses. The significant strides in treatment efficacy and the role of mHealth permit healthcare professionals with an mHealth permits to maintain the continuous communication and ensure the comprehensive mHealth involvement in the management of ALL. (American Cancer Society 2022; Inaba and Pui 2021: 1926.)

The survival rates of ALL has substantially increased from 35% in the 1960s to over 90% in the 2022. In Finland, around 50 children develop acute lymphoblastic leukemia disease annually with the outlook of childhood acute lymphoblastic leukemia improving 80% to 90%. (Lohi et al. 2013; Tantawy et al. 2013: 204-10.)

This study is important for assessing the impact of mHealth technologies on the parental management of acute lymphoblastic leukemia (ALL) and it highlights the empowerment of parental management with digital tools to improve their capacity to manage their children's illness. By examining the role of mHealth applications, this

study contributes to understanding of how emerging digital health technologies can be augment patient care, particularly in pediatric oncology. Despite the potential care, a clear research gap exists in evaluating patient care efficacy from perspective of parental management (Whittaker 2012: 479-487; Holman 2018.)

This bachelor's thesis will provide the comprehensive knowledge of how parental management in acute lymphoblastic leukemia (ALL) treatment has been transformed through utilization of mobile health applications. The purpose of this bachelor's thesis is to describe the parental management in treating childhood acute lymphoblastic leukemia through mobile health applications in pediatric nursing. This thesis improves knowledge about parental management of acute lymphoblastic leukemia treatment through mobile health applications in pediatric nursing.

2 Background

This part of thesis discusses theory and background of the topic. This study focuses on key terms and providing a fundamental understanding of leukemia with a particular emphasis on ALL, mHealth or mobile health applications, nurses' role during the treatment, acute lymphoblastic leukemia (ALL), children, parental management and treatment of acute lymphoblastic leukemia

2.1 Mobile health applications and mHealth

MHealth involves using mobile and wireless devices to achieve health objectives. These applications are diverse and multifunctional, including mobile health applications, health-related messaging, remote monitoring and teleconsultation. Mobile health applications are software developed for mobile devices with purposes aligned with mHealth goals (Jong et al. 2020: 2415-2429.)

People access these smart applications through mobile phone devices, which are valuable tools in healthcare systems. EHealth encompasses a wide array of applications, defined by the World Health Organization as the conveyance off health resources and services through electronic means, which includes methods such as telemedicine. It is acknowledged as one of the most rapidly expanding resources for augmenting healthcare access and quality. (World Health Organization 2020.)

Mobasheri et al. (2015), mentioned that mobile health applications are now more common for gaining and providing health information for nurses and family members such as parents. Mobile health applications provide healthcare information and health data to track treatment progress. These applications are easy to adopt and have portable as well as the ability to connect healthcare experts everywhere. (Ozdalga, E., Ozdalga, A., and Ahuja, N. 2012: 128; Mobahseri et al. 2015: 683-689.)

By utilizing mobile health applications, patients and parents can have quick sessions and avoid physical contact, helping bridge gaps between various elements. Through mHealth it is easy to provide health information, healthcare access, treatment instructions and managing the symptoms as well as medications administration at home.

The literature uses the term mobile health application interchangeably telehealth and telemedicine, all part of eHealth, which provides wireless technologies and mobile devices (Mobasheri et al. 2015: 683-689; Jong et al. 2020 2415-2429.)

Mobile health applications improve communication and educational outreach. While these applications are positioned to bridge gaps in healthcare delivery, there is limited research on their integration into existing healthcare frameworks and their compatibility with various socioeconomic groups. Mobile health applications align with mHealth goals, including apps for managing acute and chronic diseases, mindfulness, mental health and personal health records. (Smith, Swallow, and Coyne. 2015: 143-159.)

2.2 Parental management in cancer care with ALL-children

Parent education and collaboration play an important role in the treatment of acute lymphoblastic leukemia (ALL). Parents of children with acute lymphoblastic leukemia usually serve as direct caregivers as a personal nurse and require proper education to manage the disease. A major part of parental management during the ALL treatment is managing side-effects management, recognizing life-threatening complications and medication administration as well as managing medication schedules (Smith et al. 2015: 143-159.) The responsibilities and emotional burden on parents are significant, as they navigate the complexities of treatment regimens, managing the symptoms and provide psychological support to their children. Parental management can greatly

influence treatment adherence and overall quality of life for parents and their children. (Smith et al. 2015: 143-159)

Parents often act as the primary coordinators of their child's care and this coordination is vital for ensuring that child receives consistent care. Effective care for parental management involves communication between clinicians and families. Post discharge planning is crucial in parental management. Specialists, social workers, rehabilitation instructors and formal psychologists support and assist parents in managing their children treatment. (Smith et al. 2015: 143-159; Hockenberry, Wilson and Rodgers 2016: 75-100.)

For cancer pediatric patients, educational resources, support group and counseling are the most essential for whole family. Smith et al. (2015) mentioned that educational resources can include on the disease, treatment protocols, side-effects and strategies for home care for the parents. For the support grouping parents get opportunity to share the experiences and gain emotional support in similar situations. Counseling services can also help parents cope with the psychological burden of their child's illness and offering the strategies for stress management. (Smith et al. 2015: 140-160.)

2.3 Acute lymphoblastic leukemia in nursing

Acute lymphoblastic leukemia is a type of cancer that disrupts the normal function of the body's hematopoietic system, which is critical for producing the cellular components of blood within the lymphatic system and bone marrow. Typically, bone marrow generates progenitor cells that mature into platelets, leukocytes (white blood cells) and red blood cells, each with distinct roles in hemostasis, immune defense, and oxygen transport (Mayo Clinic 2022.)

In leukemia, this regulated system is compromised as the bone marrow produces excess of immature white blood cells, known as blasts. These immature white blood cells are dysfunctional, failing to provide adequate immune protection and lacking the full capabilities of mature cells. Acute lymphoblastic leukemia has two subtypes: B-cell and T-cell. B-cell ALL is the type of blood cancer distinguished by the abnormal and uncontrolled growth of B-lymphoblasts within the bone marrow. The proliferation of blasts cells in the bone marrow results in anemia, neutropenia and thrombocytopenia (Zhang, Habeebu and Li 2022; Leukemia: Mayo Clinic 2022.)

Furthermore, the uncontrolled proliferation of these cells outcompetes the production of normal blood cells, leading to diminished immune response and increased risk of infection. Leukemia is classified based on disease progression and cell type. Genetic and environmental factors play an important role in the cause of leukemia. Risk factors such as Down syndrome, prior chemotherapy, chemicals and family history of leukemia can contribute to its development (Belsky, et al. 2021: 1121-1128.)

2.4 Treatment of acute lymphoblastic leukemia

Treatment options for ALL include radiation therapy, chemotherapy, targeted therapy and chemotherapy with a stem cell transplant. Immunotherapy is a new type of treatment being tested in clinical trials. Chemotherapy involves using medications to halt the growth of cancer cells by either destroying them. These drugs are administered orally or injection or veins, allowing them to enter the bloodstream and target cancer cells throughout the body (Childhood Acute Lymphoblastic Leukemia: National Cancer Institute 2022.)

Radiation therapy uses high energy x-rays to kill the cancer cells. Radiation therapy administered to pediatrics patients with leukemic cells in the brain, spinal cord or testicles. Stem cell transplant chemotherapy is also the treatment, but it is not regular treatment until a child is in a very high-risk group or has relapse from leukemia. Similarly, targeted therapy is also the type of treatment to kill the cancer cells but targeted therapy is less harmful to normal cells compared to chemotherapy and radiation therapy. (American Cancer Society 2024.)

2.5 Nursing assessment and monitoring

Nursing monitoring and assessment during treatment of leukemia in pediatric patients are critical encompassing psychosocial and physical components. Initial assessment depends on diagnosis baseline data and health history as well as physical examination. Nurses always assess signs and symptoms of ALL such as tiredness, bruising, fever, bone pain and bleeding. During chemotherapy, nurses monitor food intake and immunization status. Vital signs monitoring is crucial, particularly during chemotherapy infusions. Nurses check temperature, blood pressure, oxygen saturation and signs of infection as well as detect early sign of treatment complications (Minasian et al. 2007: 5128-5132.)

Nurses monitor blood counts and liver as well as renal function of the body. Frequent laboratory tests are essential to monitor during ALL treatment. Nurses report all results and communication concerns to the oncology team. They assess chemotherapy side-effects such as nausea, vomiting, diarrhea, constipation, and changes in mental status. They also monitor other life-threatening complications during the treatment (Arber et al. 2016: 2391-405.) Nurses serve as a role model for cancer patient teaching hygiene, pain management, aseptic techniques and comfort measures with appropriate medications. Effective nurse-led education is essential. Nursing education and support are crucial as nurses often serve as the primary contact for patients and families. Nurses guide patients and families through survivorship and treatment effects. (Toruner and Atlay 2018:156-164.)

Nursing interventions focus on managing chemotherapy side effects and disease symptoms, including infection prevention, pain management, nutritional support and adherence to treatment. Each intervention depends on patient's symptoms, treatment protocol and therapy response (Toruner and Atlay 2018:156-164). Nurses educate families about the treatment and how to manage the side effects and monitor symptoms at home. They train family members to administer medications and care for central lines at home. During the treatment, nurses ensure families have all necessary drugs for central lines and provide frequent support to families. (Salvetti et al. 2021:156-163.) Nurses frequently assess pain using the pain scales and manage it through pharmacological interventions, positioning, and other comfort measures. Pain management involves comprehensive assessment and application of pharmacological interventions such as analgesics (Hockenberry, Wilson and Rodgers 2016: 266-280.)

Non-pharmacological techniques such as relaxation, cold and heat applications are also used. Pain assessment varies by patient, so nurses educate families on monitoring pain intervention effectiveness, side effects and patient condition. Effective pain management can improve the quality of life for patients (Hockenberry, Wilson and Rodgers 2016: 266-280.)

2.6 Role of parents and nurses in cancer care

The role of parents in cancer care is pivotal, especially for pediatric patients, as they are integrated with the entire care team. Parents provide emotional support, help to manage the child's treatment, schedule and assist with day-to-day care.

According to Woodgate and Degner (2003), in pediatric oncology, parent-led interventions affect adherence to treatment protocols positively. Parents often take on roles such as administering medications, monitoring infection symptoms, identifying signs of complications and providing comfort during the treatment. Parents act as advocates for their children in various healthcare settings. Additionally, psychosocial and emotional support by parents toward pediatric patients is fundamental. (Woodgate and Degner 2003: 479-491.)

Nurses are the most important figures during the treatment of any illness because they assess everything, including the psychosocial and emotional well-being of patients and their relatives. This includes addressing depression, anxiety and signs of distress as well as providing the services related to psychosocial support. Social and psychosocial support provided by nurses to children with cancer is a vital part of comprehensive care, addressing the social and developmental needs of the patients. (Hockenberry, Wilson and Rodgers 2016: 783-807.) Nurses use remote services such as mobile health applications to track the status of disease and communicate with parents through different channels such as phone calls, text messages etc. A pediatric nurse must build strong relationships with the patients and their parents to establish trust. Nurses share the information together while changing the shifts. The sharing of patient information between two nurses is vulnerable to communication errors. (Starmer et al. 2017: 319-329.)

Mobile health applications are effective systems that promote health services via new technologies. Mobile health applications are easy to handle when booking appointments, monitoring treatments and so on. These communication tools help to overcome barriers between nurses and parents such as transferring the patients' responsibility, building the care point incoming and outgoing nurses and sharing or exchange patient during their hospital visits. (Shan et al. 2019: 877-887; Nguyen et al. 2022: 331-341.)

The World Health Organization (WHO) defines that mobile health applications provided valuable information by such as mobile phones, patients monitoring devices and digital devices. They were developed to support communication relatives such as parents and nurses. Digitalization is now becoming common and easily accessible for everyone at any time. Digital health applications, mobile health applications, mHealth, telehealth

and eHealth provide contactless services to both patients' caregivers and their relatives including parents. (Moss, Sule and Kohl 2018: 57-58.)

Communication tools in pediatric nursing refer to various methods and resources designed to enhance effective communication between nurses and parents. These tools are utilized considering the ages, interaction and developmental stage of children, helping them to communicate with nurses and parents. Families and nurses can actively participate in care and assist in conveying medical information for treatment and care plans. Communication plays an important role for providing emotional support, reducing anxiety, establishing trust and educating children alongside parents. (Martinez-Perez et al. 2013: 120.)

In Finland, as an mHealth tool people use the Kanta service, where they find all information related to medical care. Parents can access their children's information and diagnosis through the Kanta-system. For the purposes, they must log in and identify themselves through their banking system online. Parents can see information for their younger children below 18 years old using their own identification with options to manage their information. (Kanta 2024). The age limit mentioned in the inclusion criteria which is under 16 years old. The New Children Hospital in Helsinki, Finland states on its front page that under 16 years old are treated in children's cancer ward within the hospital, whereas those above 16 years old are treated in a the same hospital as adults. Therefore, this research focused on children below 16 years old (New Children Hospital, Helsinki 2018.)

The Helsinki University Hospital (HUS) has currently inaugurated a state-of-the-art children's hospital, marking a milestone in pediatric healthcare in Helsinki. The new hospital stands as a beacon of excellence among pediatric wards. The facility integrates innovative technologies and child-friendly environments and features multidisciplinary team of healthcare professionals dedicated to providing excellent treatment for young patients (Helsinki University Hospital 2021.)

Omaolo is one of the biggest platforms which is currently used by every person in Finland to contact the healthcare professionals through eHealth. Healthcare professionals consult with experts and assess their conditions through video calls or chat by inquiring their symptoms and condition (Omaolo 2024.)

Mobile health applications are the part of ehealth which is commonly used in welfare healthcare system. Patients and their relatives or parents can download the apps on their devices such as mobile phones, tablets or on other to quickly receive responses and information even wherever they are. Over the past few years, there has been development in mobile health applications to increase the awareness of contactless treatment and ease of use. (Shan et al. 2019: 877-887.)

3 Purpose, aim and research questions

The purpose of this bachelor's thesis is to describe the parental management in treating childhood acute lymphoblastic leukemia through mobile health applications in pediatric nursing.

The aim is to improve the knowledge of parental management in treating childhood acute lymphoblastic leukemia through mobile health applications in pediatric nursing.

The research question of this thesis aimed to answer is:

1. How do mobile health applications impact parental management in treating childhood acute lymphoblastic leukemia?

4 Methodology and methods

Descriptive literature review approach has been used in this thesis as a qualitative method. In nursing science and healthcare research, a qualitative descriptive literature approach is commonly used due to its simplicity, utility and flexibility (Doyle et al. 2020: 443-445). It aims to evaluate, summarize the findings, and identify relevant studies in a systematic manner. For a researcher a systematic review usually allows new research to be designed and to help avoid unnecessary duplications in studies (Yamashita and Yoshioka 2022: 1205-1210.)

This method enables the identification and analysis of parental management and accessibility towards new technology, as well as the role of nursing during the treatment of acute lymphoblastic leukemia. The descriptive approach was appropriate for summarizing findings, providing a deeper understanding the role of parental

management and nursing interventions through mHealth during the treatment (Burns and Grove 2009: 92.)

This methodology maps out the current academic landscape on the research topic. It serves to identify the volume of existing research, summarize findings and to pinpoint gaps in knowledge (Burns and Grove 2009: 38, 90-92). A descriptive review is a systematic approach which provides more comprehensive methods for qualitative research method. It is a type of review that offers a summary and overview of the existing literature on a particular topic or research question. Systematic reviews typically allow researchers to design new study avoid unnecessary duplications (Holly, Salmond and Saimbert 2011; Burns and Grove 2009: 507-508.)

Descriptive review offers a narrative and qualitative synthesis of the available research. They enable researchers to familiarize with existing knowledge and theories related to the topic, which essential given the vast amount of material from past research in healthcare. Descriptive literature reviews provide a comprehensive overview based on current knowledge in the study and help to identify the gaps based on research question. (Holly, Salmond and Saimbert 2011.)

4.1 Data collection

The PICO-method has been used to formulate the research question for this thesis. When the research question were formed, the author began searching for studies available to answer the research question.

The PICO framework is a methodological tool used in both quantitative and qualitative research to frame and guide the development of research question. In the field of health and social sciences, the acronym PICO stands for Patient, Interest, Context (Methley et al. 2014: 2). In this thesis work Patient is under 16 years old child, Interest is mobile health applications or mHealth and Context is improvement in parental management through mobile health applications (see table 1).

PICO-Framework

Patient	Under 16 years old
Interest	Mobile health applications
Context	Improvement in parental management through mobile health applications

Table 1. PICO-Framework

The process of the selecting articles was started by reviewing the article retrieving from appropriate databases. Furthermore, based on inclusion and exclusion criteria articles were reviewed afterward title and abstract of each article assessed. Inclusion criteria of this study is articles which are in English language, studies that answer to research question, articles must be nursing science articles and primary studies, study includes parents, nurses, communication, mHealth, eHealth, acute lymphoblastic leukemia, children, mobile health applications and age group should be below 16 years old. Exclusion criteria of this study is article written other than English language, selected studies that do not answer the research question, studies other than nursing science articles and primary studies, study include AML, CCL, CML and above the 16 years old age group. Inclusion and Exclusion criteria has presented in table 2.

Inclusion Criteria	Exclusion Criteria
Articles written in English	Articles other than English Language
Studies that answer to research question	Does not answer the research question
Nursing science articles/Primary studies	Other than nursing science articles

Study includes Parents, Nurses Communication Leukemia Acute lymphoblastic leukemia mHealth, eHealth Children Mobile applications	Study include AML, CML, CCL.
Age group under 16 years old	Above 16 years old

Table 2. Inclusion and exclusion criteria

4.2 Data search and selection

The data selection process initiated in selecting the articles written in English language. In addition, the articles were excluded which did not answer the research question. In this thesis the prime focus has remained on reliability of the databases (see table 3). The table presents the search strategy conducted by the researcher. Boolean phrases strategy was used for search terms to get the results related to the topic of the thesis work.

In CINHALL database the search sentences that were utilized are following, mobile health application AND acute lymphoblastic leukemia AND management, Telemedicine AND acute lymphoblastic leukemia, leukemia AND caregiver support. The initial number of hits was n=465. Based on their titles, n=425 articles were excluded, leaving n=40. From these n=40 articles, n=25 were excluded based on their abstracts, and n=15 were included. After a full-text review of the n=15 articles, n=12 were excluded, resulting in n=3 articles being included in this study.

Following are the search sentences that were utilized from Medline databases, Telemedicine AND acute lymphoblastic leukemia AND caregiver support. The manual search were Acute lymphoblastic leukemia AND telemedicine AND parents AND leukemia. The number of hits were n=7, in total n=2 articles were excluded based on title and included n=5. Based on abstract n=4 were included and based on whole text n=2 articles have been included in this study. In addition, manual search was utilized by researcher to get more studies from google scholar. The researcher also searched

from other articles' references. Manually search sentences were Acute lymphoblastic leukemia AND telemedicine AND parents AND leukemia. The number of hits were n=10, in total n=3 articles were excluded and based on title n=7 included. Based on abstract n=5 were included and based on whole text n=2 articles have been included in this study. The database search table has been presented below (see table 3)

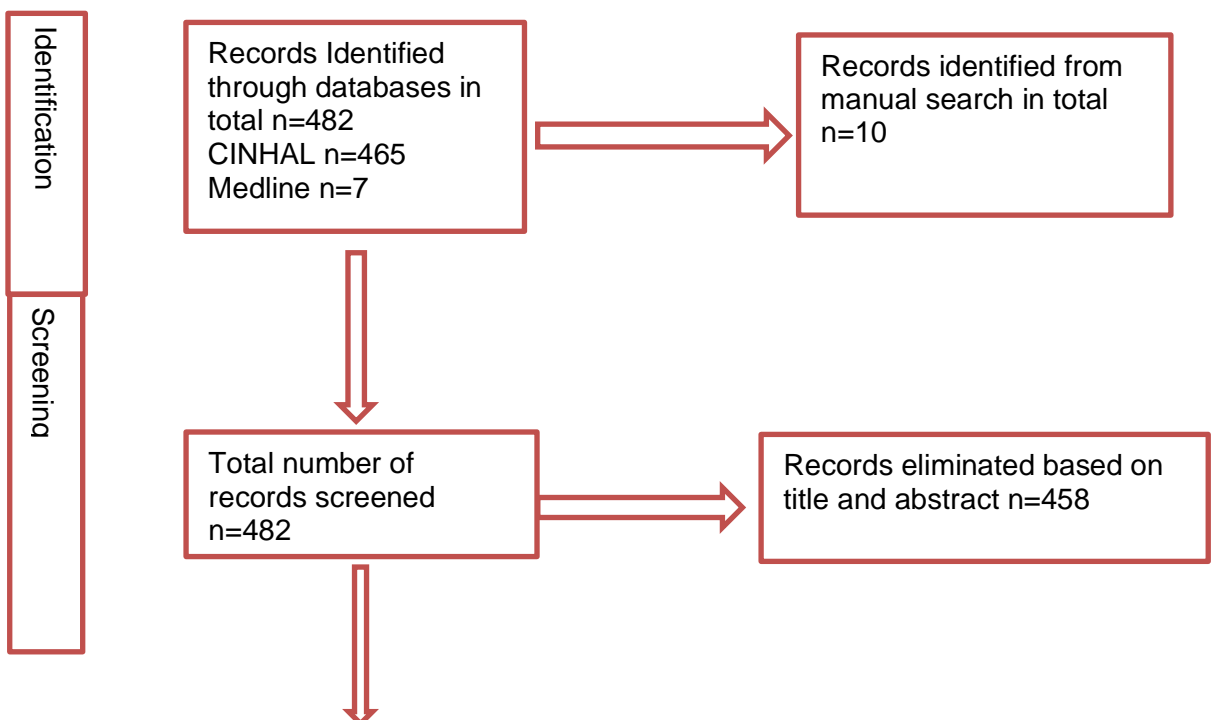
The study in total included n=482 articles from Medline, CINAHL databases and manual search by applying search sentences related to the main title. Based on title n=430 articles were excluded, similarly based on abstract in total n=28 articles were excluded. The remaining n=24 articles have been read by researcher thoroughly based on whole text. After reviewing the articles n=17 more articles were excluded due to non-nursing science domain and did not answer the research question. In this study n=7 in total articles were included based on inclusion criteria (see table 2). All n=7 articles are shown in appendices 1.

Database	Search sentence	Limiters	Number of hits	Included based on title	Included based on abstract	Included based on full text
CINAHL	mobile health application AND acute lymphoblastic leukemia AND management. Telemedicine AND acute lymphoblastic leukemia, leukemia AND caregiver support	English	n=465	n=40	n=15	n=3
Medline	Telemedicine AND acute lymphoblastic leukemia AND caregiver support	English	n=7	n=5	n=4	n=2

						14 (34)
MANUAL	Acute lymphoblastic leukemia AND telemedicine AND parents AND leukemia	English	n=10	n=7	n=5	n=2
Total						Total: n=7 studies included

Table 3. Database Search Table

A Prisma diagram was employed in this thesis to prove the transparency for the selection of articles. This diagram typically records the number of articles to identified, assessed for eligibility and included in the final analysis. It helped the researcher identify records through database searching, followed by the removal of duplicates and screening of articles based on inclusion and exclusion criteria. This diagram also provides to reader transparency and clarity regarding the selection process of studies included in the review and helps them to understand the methodology (see Figure 1). Records identified for this study in total n=482 from CINHAL database n=465, Medline n=7 and Manual search n=10. All together n=458 studies have been eliminated based on title and abstract with that remaining article n=24 has been read by researcher in whole text, n=17 more articles have been eliminated for not answering the research question. In total n=7 articles have been included in this study n=5 from databases and n=2 articles from manual search.



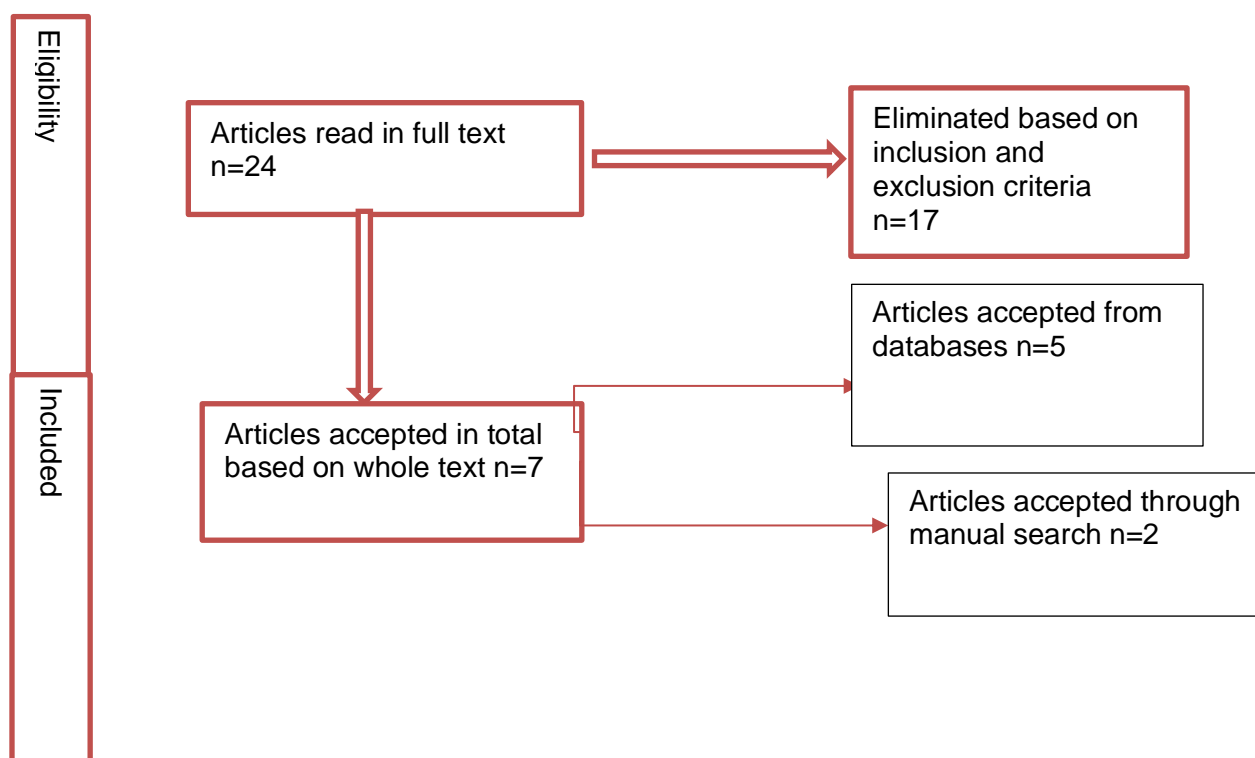


Figure 1. Prisma diagram

4.3 Data analysis method

Inductive content analysis (ICA) was used in this thesis to analyze the results, that is usually common in nursing studies (Elo and Kyngäs 2008: 107). Inductive content analysis is a qualitative research method to use systematically interprets and describes the actual meaning of qualitative data by identifying the patterns and coding. This approach allowed researcher to find the frequent and significant patterns in data without structured methodologies. (Braun and Clarke 2014.)

The initial step in this process involved thoroughly familiarizing oneself with the selected data and interpreting it. This procedure encompasses meaning units and open coding, the development of categories and abstraction (see table 4). During the open coding phase, heading and notes are annotated directly into the text. These headings are then gathered from the margins of the coding sheets and categories are freely formed. They support each other's concept and in the end those concepts are carried all together in generic and sub- categories to form main categories. (Coughlan and Cronin 2017.)

Inductive content analysis supported to summarize the data, findings and key facts. The process began by selecting and preparing the data to create units and codes. Initially codes were created by reading through selected studies to identify significant elements and open codes that is based on categorization. Data was further divided into categories such as main category, sub-category and generic category (see figure 2). Data coding is related to the selected studies that is being analyzed with the aim of this study being to improve the knowledge and answer the research question. (Elo and Kyngäs 2008: 115; Burns and Grove 2009: 528.)

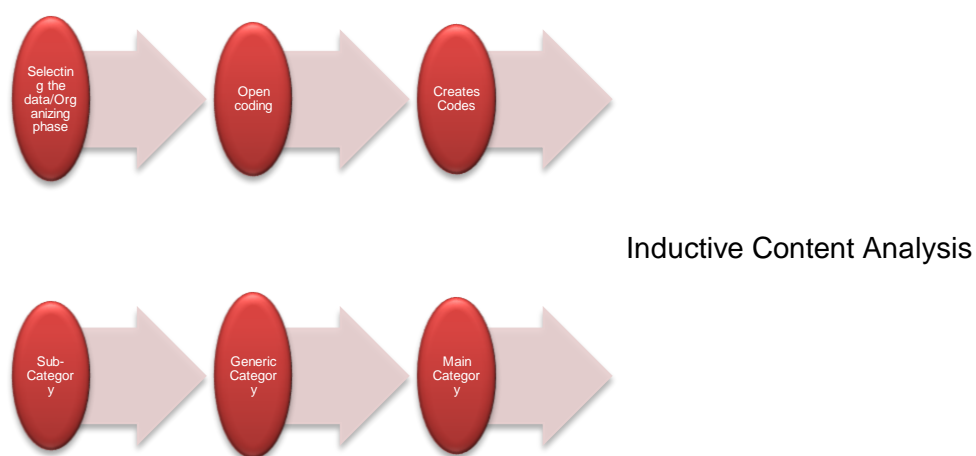


Figure 2. Procedure of inductive qualitative content analysis

This study conducted inductive content analysis and analyzed articles one by one. As mentioned by Elo and Kyngäs (2008: 107) the content analysis is either deductive or inductive. Inductive and deductive consist of three stages, which are preparation, organizing and reporting. (Elo and Kyngäs 2008: 107.) Synthesis is also known as content analysis. It was the main method to draw the results and finding from selected studies based on literature review. During the preparation phase author always

The data were then organized and categorized into meaning units. These meaning units were coded and categorized into sub-category, generic category and main category. (Coughlan and Cronin 2017.) The main purpose of utilizing the inductive content analysis was to connect the relationship between study's objectives and the data produced from the selected studies (Thomas 2016: 237).

The various generic categories answered the to the main category which was the established research question. The research questions was “How do mobile health applications impact parental management in treating childhood acute lymphoblastic leukemia?” During the analysis, a short table is created which was extracted from inductive content analysis of this study (see table 4).

Meaning Unit	Coding	Sub-category	Generic category	Main category
The main findings of this study are parents found mHealth applications improving medication management, facilitating communication with healthcare teams and tracking the treatment progress through apps to increased parental vigilance adhering to the treatment plan.	Real-time treatment tracking Appointment tracking and medication reminder	Impact on treatment adherence Effective way for tracking the treatment of ALL	Effectiveness of mHealth applications Enhancing treatment adherence through mobile health applications	Role of mobile health applications in treating childhood ALL enhancing the parental management

Table 4. Inductive content analysis in this study

5 Results

In this thesis work, total seven (7) studies were considered through reliable databases. Studies are undertaken from different countries such as three (3) studies are from China (Wang et al. 2015; Wang et al. 2016; Wang et al. 2018.) one (1) from New Zealand (Aburn and Got 2014) one (1) from Egypt (Mohamed, Yousef and Ayed 2022) one (1) from Indonesia (Novrianda et al. 2023.) and one (1) from The USA (Goldsmith,

Silverman and Safran 2002.) In detail all selected articles have been presented below (see table 5).

Country	Year	Author(s)	Methods and Methodology
China	2016	Wang, Yao, Shen, Zhang, Wang, Liu, Geng and Yuan	Qualitative study A pilot study of usability and effectiveness
China	2018	Wang, Hoxwell, Shen, Geng, Wu, Shen. M., Zhang, Xie, Wang., L. and Yuan	Qualitative study Quasi-experimental pre- and post design study
China	2015	Wang, J., Yao, Wang, Y., Zhou, Liu, Geng and Yuan	Qualitative study Multifaceted literature review and semi-structural individual interviews with that group interviews
Indonesia	2023	Novrianda, Herini, Haryanti, Supriyadi and Lazuardi	Qualitative study A user-centered design approach
New Zealand	2014	Aburn and Got	Qualitative study and Quantitative study
Egypt	2022	Mohamed, Yousef and Ayed	Qualitative study Quasi-experimental design approach
The USA	2002	Goldsmith, Silverman and Safran	Qualitative study Structured interviews and telephone interviews

Table 5. List of selected articles

Based on research question, the data was categorized into main units during the analysis process. The main categories further divided into generic categories (see table 6).

Main category	Role of mobile health applications in treating childhood ALL enhancing the parental management
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Generic categories	<p>Effectiveness of mHealth applications</p> <p>Parental satisfaction and long-term impact</p> <p>Psychological and social benefits</p> <p>Usability and accessibility</p>
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Table 6. Categories formed through data analysis

The selected studies focused on mobile health applications and mHealth interventions for parents of children with acute lymphoblastic leukemia (ALL). These studies illuminated the transformative potential of technology in pediatric nursing care from the parental management perspective. Collectively, they explored the effectiveness on mHealth, usability, parental satisfaction, long-term impact and psychological as well as social benefits related to children's cancer treatment. (Wang et al. 2015; Wang et al. 2016.)

5.1 Role of mobile health applications in treating childhood ALL enhancing the parental management

5.1.1 Effectiveness of mHealth Applications

Recent studies emphasize the effectiveness of mobile health applications in enhancing parental management of ALL. These applications offer on demand access to tailored healthcare information and existing healthcare services. The digital platforms allow parents to make informed decisions and manage daily care more efficiently. (Wang et al. 2018.) The impact of these tools extends to improving medication management, facilitating communication with healthcare teams and providing vital educational support. These features enable parents to adhere to complex chemotherapy protocols crucial for the treatment of ALL. (Aburn and Gott 2014: 300-305.) Mobile health application was effective way to support parental management and provide better care for their children during life-threatening treatment. Healthcare professionals play a pivotal role in educating parents about their child's condition, symptom management and treatment plans. Parents valued opportunities for open dialogue with medical and

nursing teams via digital platforms. (Aburn and Gott 2014: 300-305; Mohamed et al. 2022.)

The study included those recommendations from parents, such as the desire standardized education across nursing staff, user-friendly literature from external agencies and an update reliable list of internet resources. Parents expressed their willingness to continue using the mobile health applications (mHealth) as a supportive tool in pediatric oncology and applications in diverse healthcare settings. (Aburn and Gott 2014: 300-305.) This aligns with the study done by Aburn and Gott (2014), which highlighted the importance of delivering education and information to parents in a satisfactory manner. For effective parental management during the treatment of disease another study found that parents need proper and updated material regularly as well as mobile supportive care to get improvement during ALL-treatment. (Mohamed et al. 2022; Aburn and Gott 2014: 300-305.)

Mobile health applications significantly enhanced parental management in treating childhood acute lymphoblastic leukemia. Another study also found that the use of digital tools helped them to organize and adhere complex chemotherapy protocols, which is crucial for the treatment of ALL. (Goldsmith, Silverman and Safran 2002; Mohammed et al. 2022.) Parents reported that mHealth tools provided essential support in managing the side effects and empowering parents by giving them a sense control over their child's treatment process. (Goldsmith, Silverman and Safran 2002).

5.1.2 Parental satisfaction and long-term impact

Another study proved that mHealth or mobile health applications are effective way to communicate and manage with healthcare professional teams during the treatment of acute lymphoblastic leukemia. Parents found that mobile health application helped them track their children treatment progress and utilized features withing the mobile health application to document symptoms and contact healthcare teams immediately without waiting for phone calls. (Novrianda et al. 2023; Wang et al. 2016.)

Parents expressed their satisfaction with the Chemo Assist of Children (CAC) application and highlighted needs for management recommendations, symptoms tracking and communication with healthcare teams. Novrianda et al (2023) reported an average satisfaction score of 4.28 out of 5, indicating a high level of satisfaction among

the parents using mobile health application. The CAC mHealth application met the needs of parents managing their children's chemotherapy related symptoms outside of hospital care. The interactive platform facilitated communication with healthcare professional, enhanced social support and reduced anxiety. (Novrianda et al. 2023.)

The study delineates that the creation and assessment of the Chemo Assist for Children (CAC) mobile health application designed to assist parents in managing their children condition. Based on parental needs, they showed interested in mHealth solutions and authors highlighted the efficient communication medium within the application. The CAC application focused symptoms management, facilitation of communication between healthcare team and parents, and providing information. (Novrianda et al. 2023.)

The tool supported parents in overseeing chemotherapy-related symptoms, enhancing the independence and empowerment of parents and children. The study evaluation of underscored the application's potential to increase parents' involvement in care and to improve the quality of healthcare specially delivery for pediatric oncology patients. (Novrianda et al. 2023; Wang et al. 2016.) Another study revealed there is significantly improvement in the effectiveness of mobile health tools in enhancing understanding and management of the disease. The study advocates integrating of such mobile health programs in hospitals to foster parental awareness and better care for children with leukemia, along with enhancing parental knowledge improved regarding to the disease and health management during the treatment. (Mohamed et al. 2022.)

Parents of children with acute lymphoblastic leukemia (ALL) reported several benefits from using the apps, including gaining credible knowledge about leukemia, feeling more prepared related to symptoms management, experiencing less stressed and increased confidence in caregiving. Parents found that the mobile health application stable, useful, simple and self-explanatory for managing the children with ALL at home. Similarly, smartphone app provided real-time communication between parents and healthcare team and effectively supported parents at home in tracking detailed information. (Wang et al. 2016; Wang et al. 2015.)

5.1.3 Psychological and social benefits

The analysis content showed that these digital platforms drastically improved the impact on parental management in treating childhood acute lymphoblastic leukemia. Wang et. al (2018), demonstrated that mHealth interventions through smartphone apps benefit several critical areas of parental management and psychological well-being. The psychological changing reported such as reducing uncertainty related to children illness, decreasing anxiety, increasing knowledge about (ALL), improving social support and reducing care burden. The study found improvements in parents' psychological health, satisfaction with care, confidence in caregiving and overall knowledge related to ALL by using mobile health applications. (Wang et al. 2018.)

The improving in psychological well-being brought quality in care via mHealth technology. The intervention showcased a significant reduction in parents' uncertainty and anxiety regarding illness and an improvement in social functions. Parents reported satisfaction with tracking symptoms and feeling better equipped in their caregiving roles. However, no significant improvement in quality of life beyond social function was observed, indicating a need for extended support and an expanded scope of mHealth capabilities. (Wang et al. 2018; Wang et al. 2016.)

5.1.4 Usability and accessibility

Mobile health applications and mHealth interventions enhance usability, support for managing chemotherapy-related symptoms, access to healthcare and pain management during the treatment. From parental management perspective mHealth interventions play vital role in addressing the multifaceted challenges faced by parents of children during the treatment of acute lymphoblastic leukemia. The applications effectively provided on-demand access on tailored information and existing healthcare services, enabling parents to make informed decisions and manage daily care more efficiently. (Wang et al. 2018; Aburn and Gott 2014: 300-305.)

The ability to send the text messages and images to the hospital staff was especially valued enhancing parental confidence and control. Parents found mHealth tools beneficial and helpful to managing urgent situations and communication needs for their children. Overall, mHealth was well received by the current generation of parents and the study introduced "aperture" as a new dimension of access in the eHealth context,

referring to the less tangible as aspects of digital communication that can cause concern. (Mohammed et al. 2022.) The efficacy of mHealth solutions are contingent upon the availability, not all patients demographics may have equal access to the necessary devices and the literacy to use them effectively which can be created disparities in care (Aburn and Got: 2014).

The selected studies developed and utilized various mobile health applications within literature review such as Care Assistant app, Chemo Assist of Children (CAC), Smartphone application, WeChat, QQ, Whatsapp and internet-based system app. Studies are three (3) from China (Wang et al. 2015; Wang et al. 2016; Wang et al. 2018.) one (1) from New Zealand (Aburn and Got 2014) one (1) from Egypt (Mohamed, Yousef and Ayed 2022) one (1) from Indonesia (Novrianda et al. 2023.) and one (1) from The USA (Goldsmith, Silverman and Safran 2002.)

6 Discussions

This thesis was aimed to improve knowledge about parental management of acute lymphoblastic leukemia treatment through mobile health applications in pediatric nursing. The main objective of this study was to answer the research question “How do parental management impact in treating childhood acute lymphoblastic leukemia through mobile health applications? And “What types of mobile health applications utilized by parents managing their children during the treatment of acute lymphoblastic leukemia?” In this section validity and reliability as well as quality of selected studies are examined.

As above mentioned studies revealed that by utilizing mobile health applications, patients and parents can have quick sessions to avoid physical contact, helping bridge gaps between various elements. Through mHealth it is convenient to provide health information, healthcare access, treatment instructions and managing the symptoms as well as medications administration at home. (Mobasheri et al. 2015: 683-689; Jong et al. 2020 2415-2429.)

The selected studies collectively highlighted that mHealth applications effectively support parents in manage chemotherapy-related symptoms, improving communication with healthcare teams and providing educational resources. The findings revealed that

mHealth applications significantly enhance parental management in treating childhood ALL. The applications provided essential tools for parents to monitor and manage their child's symptoms, track medication schedules, and communicate effectively with healthcare providers. (Novrianda et al. 2023.)

Parents reported a high level of satisfaction with mHealth tools, noting that these applications improved their ability to manage their child's treatment, reduced anxiety and increased their confidence in caregiving. This aligns with the background discussion on the critical role of parents in providing emotional support and managing day-to-day care for pediatric patients. (Mohammed et al. 2022; Wang et al. 2016.)

These findings underscore the background's emphasis on the important of digital tools in modern healthcare, particularly in facilitating efficient communication and supporting comprehensive care plans. The use of applications such as Chemo Assist of Children (CAC) and Care Assist app demonstrated specific benefits, including improved symptom management, enhanced communication with healthcare teams, and better access to healthcare services. (Novrianda et al. 2023; Wang et al. 2016.)

The findings also emphasized the psychological benefits of mHealth apps. Mobile health applications with parents reported reduced uncertainty and anxiety about their child's illness and a significantly improved understanding of ALL. The outcomes indicated that mHealth tools are providing to parents with the necessary support and information to enhance ability to manage the child condition. This study corroborates the findings of Wang et al. (2018), that also observed improvement in treatment, parental satisfaction and reduced anxiety through the use of mHealth intervention (Wang et al. 2018). The positive impact of mHealth applications suggested that integrating such tools into standard care practices could enhance parental support and childcare outcomes. (Wang et al. 2016; Wang et al. 2018.)

The studies identified limitations, including the variability in the quality of mHealth applications and the need for more comprehensive support systems to address all aspects of quality of life affected by pediatric ALL. The results suggest that while mHealth applications significantly improve certain aspects of care, there is still a need for broader support mechanisms to ensure comprehensive care and improved quality of life for both patients and families (Wang et al. 2018). The effectiveness and

accessibility of these mobile health applications have been limited due to diverse socioeconomic groups. (Goldsmith, Silverman and Safran: 2002).

6.1.1 Research ethics

Ethical research is crucial for generating knowledge and evidence-based practice. Ethical consideration in research involves conduction of research honestly, publishing quality research and accurately reporting findings (Dooly, Moore, and Vallejo 2017: 351-362).

Ethically, a researcher obtained data from reliable databases. Before conducting the research, researcher ensured that the studies have included ethical information regarding their data collection methods. In this literature review, a researcher provided all the relevant references in references section and detailed the material used in this study as well as selection criteria for the studies. Misconduct research has been avoided during this work and integrity was maintained by the researcher throughout the entire thesis process. This thesis work checked by using Turnitin for plagiarism to ensure ethical research. (Burns and Groves 2011: 136-137.)

6.1.2 Research validity

This study utilized reliable sources in the literature review, demonstrating the study's validity. Validity in research refers to truthfulness and this study demonstrated a sound theoretical framework and conceptual research design (Burns and Groves 2001: 362-364). To establish the validity of this research, a complete definition and detailed operationalization were provided for measuring both dependent and independent variables. The researcher considered validity and reliability in measuring the quality of the research work. Although, the researcher attempted to include more articles, the selection was limited to studies that answered the research question.

Sources provided by the library of Metropolia University of Applied Sciences were used to support the validity of this study. Additionally, a researcher attended all relevant sessions to obtain reliable information. A personal session provided by a librarian was attended by the research, who solely participated in this thesis work. The data collection and data search processes are clearly stated in the methodology section and data analysis was conducted using induction content analysis. All measurement tools were carefully selected to ensure validity and reliability in this research work.

The quality of the selected articles for this literature review was assessed by applying various criteria. The JUFO-portal was used to determine the quality of selected articles for this study. It is crucial for researcher to assess the quality for academic credibility and recognition. All seven selected articles' journals were ranked between 1-3 in JUFO-ranking. JUFO-ranking provided a centralized platform for researcher to find the accurate ranking of each journal. The ranking ranges from 0-3, 0 indicates basic level of journal and 3 indicating the highest level of international recognition. Journals with a ranking 4 indicate high impact in their fields, strong reputation and rigorous peer review processes. (Publication forum 2023.)

The JUFO ranking system which stands for Publication forum is primarily used in Finland by the Federation of Finnish Learned Societies to rate the quality of scientific journals. The JUFO-portal is the platform where a researchers can find the ranking of all journals. It provides information about journals, scientific series, conferences, and book publishers as well as recommendations for the rating of journals, conferences. (Publication forum 2023.)

7 Challenges and Limitations

The aim of this thesis was to improve knowledge of parental management in treating childhood acute lymphoblastic leukemia through mHealth. The selected studies were chosen from reliable databases based on above mentioned table (see table 2) inclusion and exclusion criteria. Despite the mobile health applications' advantages, it faces challenges regarding to existing healthcare frameworks. The effectiveness and accessibility of these mobile health applications have been limited due to diverse socioeconomic groups. (Goldsmith, Silverman and Safran: 2002.) The efficacy of mHealth solutions are contingent upon the availability, not all patients demographics may have equal access to the necessary devices and the literacy to use them effectively which can be created disparities in care. (Aburn and Got: 2014.) While mobile health applications improve various aspects of parental management and healthcare delivery but these improvements do not always translate into enhanced quality of life beyond social support and psychosocial support. Wang et al. (2018), suggested a need for broader support systems and resources all aspects of quality of life affected by pediatric acute lymphoblastic leukemia (Wang et al. 2018).

8 Conclusion

This thesis explored how mobile health applications not only impact on management tasks for parents during the treatment but also foster a collaborative environment with healthcare professional teams. In this thesis, it has been explored the transformative potential of mobile health (mHealth) applications in managing the treatment of acute lymphoblastic leukemia (ALL) in pediatric patients on parental management. The synthesis of selected literature revealed that mHealth tools significantly impact parental management, offering a platform for real-time communication with healthcare professionals, educational support, symptom tracking, and the management of chemotherapy-related symptoms outside hospital settings.

The findings underscored an increase in parents' knowledge, satisfaction, and psychological health while using these applications. This thesis concluded that mHealth applications present a significant advancement in the treatment and management of acute lymphoblastic leukemia, providing the crucial support for parents and healthcare providers. Mobile health applications are valuable tools in the context of pediatric ALL treatment, enhancing the efficacy of parental management, care delivery, and the psychosocial well-being of families. This evolution in healthcare delivery not only support the patients and their families but also aligns with broader public health goals of improving outcomes in childhood acute lymphoblastic leukemia treatment.

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Appendix 1. List of Selected Studies

	Author, date and country	Titles	Aim and purpose	Methodology and Methods	Participants	Results
1	Novrianda, D. et al 2023 Indonesia	Chemo assist for children mobile health application to manage chemotherapy-related symptoms in acute leukemia in Indonesia: a user-centered design approach	<p>The objective of this study is to develop a user-centered mHealth application called “Chemo Assist for Children” (CAC)</p> <p>The aim of this study to support parents of children with leukemia during chemotherapy treatment</p>	In this study, the development of the CAC application went through multiple phases and methods. Study phases included in both qualitative and quantitative methods.	n=10 participants were parents of Leukemic children	Evaluation by end-users revealed that CAC mHealth application is valid, accessible and appropriate for users. Application enhances symptom management independently, improve communication between parents and health care provider for children treatment.
2	Aburn and Gott 2014 New Zealand	Education Given to Parents of Children Newly Diagnosed with Acute Lymphoblastic Leukemia: The Parent’s Perspective	The objective of the research was to explore the views and the firsthand accounts of parents who are looking after children recently diagnosed with acute lymphoblastic	A qualitative methodology was used in this study	In this study n=12 parents of children participated who have acute lymphoblastic leukemia disease from a	n=12 participants in the study, nine were mothers. There were varying levels of education among parents, with five participants having secondary education and five having completed education post-secondary school. The remainder of participants did not specify their education level. The children who were diagnosed with acute lymphoblastic leukemia were

			leukemia , focusing on the instructions as they received before being initially discharged from the hospital.		tertiary pediatric oncology and hematology in New Zealand. Semi-structured has been used.	of a variety of ages, ranging from two to 14 years of age.
3	Wang et al 2016 China	Supporting Caregivers of Children With Acute Lymphoblastic Leukemia via a Smartphone App: A Pilot Study of Usability and Effectiveness	This study's purpose is to conduct an initial assessment of the application's user-friendliness and efficacy.	In this study mixed methods have been used to evaluate the app.	Total number of participant were n=21 N=6 were healthcare providers N=15 parents of children who had acute lymphoblastic leukemia	The results indicated that the app had the potential to support caregivers of pediatric cancer patients, and further empirical interventional studies were planned to examine its clinical effectiveness
4	Wang et al 2018 China	mHealth Supportive Care Intervention for Parents of Children With Acute Lymphoblastic Leukemia: Quasi - Experimental Pre- and Post design study	The study aimed to assess the impact of the mHealth intervention on various outcomes related to parents' knowledge and well-being.	In this study quasi-experimental pre- and post design methodology has been used. The approach is Quantitative in nature but for	A total of n=101 parents were enrolled in the study, with n=51 in the intervention group and n=50 in the observation group	The results are for this study uncertainty in illness, reduced anxiety of parents. This study found that mHealth is improving social function and decreased the need of knowledge.

				collecting data qualitative approach has been used		
5	Mohamed et al 2022 Egypt	Effectiveness of Using Mobile Health Supportive Care Intervention on Mother's Awareness of their Children with Leukemia	This study aimed to evaluate the effectiveness of utilizing mobile health supportive care intervention on parental awareness.	Quasi-experimental methodology was utilized to achieve the aim of this study.	n= 60 educated mothers of their children diagnosed with leukemia.	Results of this study found that there was drastically improvement in participated mothers' awareness by using mobile health intervention of children with leukemia.
6	Wang et al 2015 China	Developing "Care Assistant": A smartphone application to support caregivers of children with acute lymphoblastic leukemia	The aim of this study was to make "Care Assistant" app to promote the Acute lymphoblastic leukemia caregivers.	The methodology for this study was multifaceted encompassing a literature review, semi-structured individual interviews with caregivers and group discussions that	In total n=23 participants were included eight were caregiver mothers, twelve cancer care professionals and three software engineers.	Care Assistant app was user-friendly and suitable for acute lymphoblastic leukemia caregivers means parents. The app was helping to parents to take care of their ALL-children to acquire more knowledge and receive more support.

				included healthcare professional .		
7	Goldsmith , Silverman and Safran 2002 The USA	Supporting home management of childhood leukemia	The aim of the study was to improve the experience and outcomes of children with acute lymphoblastic leukemia in adherence medication management, side effects management, communication with healthcare team and using the computer for ALL home management at home	The study conducted structured interviews using telephones interviews.	n=25 parents participated and 72% were mothers	Parents of children with ALL were struggling at that time at home to manage the medication and adapting the challenges to cope with ill-children. At that time parents needed urgent any tool that would help them to organize the care need sof their children. Parents were also concerned about the medication side-effects. Cancer CareLink was the important for parents to hear about acute lymphoblastic leukemia disease and they realized that it was highly beneficial for them to get knowledge and education to improve clinical outcomes.