Cape Peninsula University of Technology

A SYSTEMATIC REVIEW ON MOBILE HEALTH (MHEALTH) INTERVENTION ON BREAST CANCER AWARENESS AND SCREENING

by

SIBINA BOLOFO

Dissertation submitted in fulfilment of the requirements for the degree

Master of Technology: Business Administration

In the Faculty of Business and Management Sciences

At the Cape Peninsula University of Technology

Supervisor: Dr Temitope Tokosi

District Six, Cape Town

Date submitted: 15 September 2022

DECLARATION

I, Sibina Bolofo, declare that the contents of this dissertation represent my own unaided work, and that the thesis/dissertation has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

Signed:  **Date: 11/07/2023**

ABSTRACT

Background: Mobile health (mHealth) interventions for improving quality of life (QoL) are rising, particularly those related to promoting prevention, improving screening, managing care and supporting cancer patients and survivors. Though there is a clear surge in the mHealth interventions for cancer patients, the related research findings are fragmented. There is an urgent need to amalgamate the extant learning's, particularly those related to the review the effect of the mHealth interventions on awareness and screening of cancer.

Objective: The purpose of this research is to conduct a systematic review of literature on mHealth interventions for different types of cancer patients and survivors, as well as summarize the outcomes & impacts of these cancer management interventions range from cancer awareness to survival.

Methods: The databases Scopus and Web of Science were used to identify, analyse peer-reviewed literature for this study using systematic literature review methods. A systematic literature review was divided into two phases: study selection, data extraction, and data synthesis.

First, relevant mHealth interventions in the context of cancer patients were identified, followed by the results of a systematic literature search and thematic summaries. A strong search protocol with well-defined inclusion and exclusion criteria, as well as a forward and backward search for relevant records, was used in a systematic literature review.

Results: This review found that mHealth interventions improve early detection and awareness of breast cancer. This is reflected in SMS being the most successful form of mHealth awareness rising as opposed to other forms such as mobile apps. Women were considered in the LMIC review.
Given the findings of the studies on the potential of mHealth in the treatment of breast cancer, it is suggested that additional research be prioritized, particularly in

her LMICs and in breast cancer patients aged 50 and up. The efficacy of mHealth awareness and breast cancer screening should be studied further in the future.

.

Discussion: The review of the literature revealed that mHealth SMS messaging resulted in significant improvements for women with breast cancer. In countries with low and middle incomes, SMS was the most successful intervention on her mHealth platform. Women used their mHealth tools to access services more frequently than men.

Conclusion: This systematic review was designed to educate health professionals and healthcare system decision-makers about using mobile messaging to raise awareness of breast cancer in women. The systematic review's findings will be published in a way to future research on mobile health interventions aimed at breast cancer awareness and prevention.

ACKNOWLEDGEMENTS

I wish to thank:

- I deeply with all my heart express my thanks to my lovely parents, siblings and friends for their encouragement and support.
- I would like to thank my supervisors, Dr T. Tokosi and Prof. Darko for their support, advice, and communication to make this research possible.
- Also, my appreciation to the Division Graduate Centre for Management Faculty of Business and Management Sciences of and the group for their assistance.
- Finally, and who were always with me, supporting me day and night, thank you for sharing with me this happiness. Thanks to all who made this opportunity possible.

DEDICATION

This dissertation is dedicated to my parents, **Maphoka Sekoala and Pitso Bolofo**, and my siblings **Seboku Bolofo and Phoka Bolofo**, and my nephew **Swelihle Ngcani,** for their emotional and moral support, continuous advice and encouragement, in what was a very difficult journey. May the Almighty God continue to take you further, above and beyond your dreams.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

ABBREVIATIONS AND ACRONYMS

ALL	= Acute lymphoblastic leukaemia
App	= Application
AYAs	= Adolescents and young adults
BSC	= Breast cancer e-Support program
CRC	= Colorectal cancer
D	= Descriptive study
F	= Feasibility study
IoT	= Internet of Things
LMIC	= Low-and-Middle-income countries
Mage	= Mean age
OAs	= Oral anti-cancer agents
PF	= Pilot feasibility study
P	= Prospective clinical trial
Pr	= Prototype development study
PT	= Pilot testing
QL	= Qualitative study
RCT	= Randomized controlled trial
RCT D	= Randomized control trial double arm study
RCT P	= Randomized control trial protocol
SMS	= Short Message Service
S	= Survey
WHO	= World Health Organization

CHAPTER ONE: INTRODUCTION AND BACKGROUND

1.1 Introduction

Mobile health (mHealth) is a type of electronic health care (eHealth) in which mobile communication technologies is utilized to help with treatments and procedures to improve health (e.g., Information about health care and the collecting of health data delivery, or the patient assessment and concern). Mobile health is thought to have a substantial influence on health processes by increasing gaining access to enhancing the standard of care while also cutting health-care costs. Services in health care offer the ability to enhance chronic illness self-management and minimize healthcare costs hospital visits provide personalized, localized, and on-demand interventions. Mobile phones, Smartphones, tablets, portable media players, and the health applications that go with them are examples of mobile devices or technologies utilized in healthcare (Fortuin, Salie, Abdullahi & Douglas, 2016). MHealth technologies provide real-time data collection, transmission, data analysis and automated reporting, as well as data storage and transformation (Leon et al., 2012).

1.2 Research Background

Mobile health (mHealth) is the use of mobile communication technologies to promote health by supporting health care practices (eg, health data collection, delivery of health care information). mHealth technologies (such as mobile phones) can be used effectively by health care practitioners in the distribution of health information and have the potential to improve access to and quality of health care, as well as reduce the cost of health services. Current literature shows limited scientific evidence related to the benefits of mHealth interventions for breast cancer, which is the leading cause of cancer deaths in women worldwide and contributes a large proportion of all cancer deaths, especially in developing countries. Women, especially in low- and middle-income countries (LMICs), are faced with low odds of surviving breast cancer. This finding is likely due to multiple factors related to health systems: low priority of women’s health and cancer on national health agendas; lack of awareness that breast cancer can be effectively treated if detected early; and societal, cultural, and religious factors that are prevalent in LMICs. The proposed systematic review will examine the impact of mHealth interventions on breast cancer awareness and screening among women aged 18 years and older.

1.3 Problem statement

Mobile health is defined as the application communication via mobile technology to improve by means of health assisting in health-care tasks (e.g., collection of health data, dissemination of health-care information). Health technologies (such as cell phones) offer the ability to enhance health-care quality and accessibility while simultaneously cutting costs. Health-care costs are being reduced. There is a severe lack of empirical data on the benefits of mobile health, and breast cancer is the leading cause of cancer death in women. Globally accounts for significant percentage all types of cancer fatalities, especially in poor nations. Women, particularly in low- and middle-income countries, are disproportionately affected nations, have a poor prognosis when it comes to breast cancer. This discovery is most likely the result of a combination of health-related factors.

1.4 Rationale and significance of the study

The goal of this research is to see health on the move interventions have contributed to the global spread of breast cancer awareness and screening. Breast cancer awareness, screening, and education may help women avoid developing the disease and dying from.

1.5 Aims and Objectives

The goal of this study is to determine the extent and character of published and unread study on the application of mobile health-based technologies in nations for cancer prevention, detection, and management. Concepts that guide it are as follows:

- Assess the quantity, quality, and scope of evidence relating to mobile involvement in health care cancer contexts globally.
- Describe important research gaps, growing challenges in low- and middle-income nations' health and cancer literature.

1.6 Research questions

- Do mobile health (mhealth) interventions have any effect on creating awareness and help for screening of breast cancer?
- What are the most important emerging themes in the evidence, as well as important research gaps?

1.7 Literature review

This review is based on the framework developed by Arksey & O'Malley (2005). The framework enables the mapping of fundamental concepts underpinning a specific research subject, as well as the available primary sources and forms of evidence, and how they might be used, particularly as a stand-alone project when a topic is difficult or has not been thoroughly studied previously (Mays, Roberts & Popay, 2001). The Arksey and O'Malley's six stages of the scoping review methodology were followed: (1) identifying the research question; (2) identifying relevant studies; (3) study selection; (4) charting the data; (5) collating, summarizing, and reporting the findings using descriptive numerical and thematic analysis; and (6) an optional consultation exercise (Arksey & O'Malley, 2005).

1.8 Search Strategy

Relevant articles are systematically identified using a search approach that incorporates relevant Keywords and search phrases in electronic databases that are appropriate and other information on cancer-related literature connected in the field of mobile health interventions on countries have also been discovered. The search phrases were developed by splitting the review issue into three domains: The subject headings (Medical Subject Headings-MeSH) for selected databases and free text words linked to the components were used to construct the search terms used to structure the search techniques. In addition, to extend the search technique, generic phrases used by other researchers were altered (Free et al, 2010), (Nurmatov et al, 2014).

To locate all of the publications that satisfied the inclusion requirements, a literature search was conducted at random in two stages. They contained, using a search technique that was designed and modified for each database. These sources are described in detail in the following sections:

1.9 Databases on the Internet

MEDLINE, EMBASE, PsychINFO, WHO Global Health Library (limited to regional indexes), Web of Science, and PubMed were searched online. Subject headings and keywords that are part of each database's search strategy were used to find all qualifying articles. After evaluating the title, abstract, and full text of relevant articles, the search results were downloaded to reference manager for screening and analysing their eligibility according to the inclusion criteria.

Sources of Further Information the following sources were used to select 8 published and unpublished publications in addition to searching electronic databases for relevant literature: Key journals are identified using the reference lists are included papers. As well as consultation with mobile health professionals among these are the Journal of Medical Internet Research (JMIR), the Journal of Telemedicine and Telecare, the Asian Pacific Journal of Cancer Prevention, BioMed Central (BMC cancer), the Journal of Biomedical and Health Informatics. Additional scanning of the reference lists of the included studies was undertaken to identify supplements to relevant literatures.

1.10 Definition of Key concepts

MHealth - The usage of mobile technology improves one's health through assisting in the delivery of healthcare services is referred to as mobile health (health) (e.g., patient observation and treatment, or health data gathering, distribution of health care information).

Breast cancer - Breast cancer is the most frequent disease among women in the globe, with 1.67% of the population new cases identified the year 2012.

Women - Women in wealthy countries may be more likely to make it through the illness, but survival rates in countries with a low and moderate income (LMICs) range from 10 to 25%.

Awareness - This is most likely due to a mix of health-system issues, such as insignificant importance for impact of cancer on women's health and national health agendas, a not having understanding that breast cancer is a serious condition if you were to be treated early, and sociological spiritual or ethnic elements common LMICs.

Screening - The mortality rate of breast cancer is high, considerably decreased by early detection and screening, especially in low- and middle-income countries (LMICs) with high levels of poverty high mortality rates.

1.11 Paradigm/philosophy

1.11.1 Paradigm

According to Khaldi (2017), the paradigm used in this study is a pattern, set of beliefs, and agreement that demonstrate the meaning of data, how it is to be collected, and how it is to be interpreted. As a result, Ma (2015) classified paradigms into three groups: interpretivist, critical, and positivist, and narrated the four elements of axiology, ontology, epistemology, and methodology that they contain. The above research implemented the fundamental process where certain beliefs.

1.12 Research approach

The papers must have been either (1) published in English or (2) released between 2008 and 2019. (3) Papers must discuss cancer screening changes and (4) publications must discuss app-based cancer screening strategies. Books, conference proceedings, dissertations, protocols, conference abstracts, protocol articles, editorials, and commentary are examples of qualitative research. They will not be included in this study. Wearables, as well as web, e-mails, twitter, social network services, vaccination, sensor, biomarker, and microchip, scope, health marketing, biopsy, portable mobile or mobile unit, Personal Health Record (PHR), and Internet of Things (IoT), will not be included. The research will exclude guidelines and news, conference booklets, periodicals, educational programs and curricular content, cancer programs, gatherings, associations (societies), white reports, bioinformatics, and big data. Studies that do not use Apps as intervention tools focus primarily on app design and development or lack screening and treatment indicators or outcomes will be excluded from the research. Furthermore, if unrelated to the research topic content is eliminated, or if information is insufficient or confused, the paper will be.

1.13 Research design/strategy

Both randomized and non-randomized research will be included in this review's study design. The non-randomized studies will include case-control, cohort, and cross-sectional studies in which mobile health was the major intervention for breast cancer awareness and screening.

1.14 Demarcation/Delimitation of study

The research settings are not limited by geography. All continents, nations, and health facilities that have conducted breast cancer mobile health research are included. This method allows for the collection of all necessary evidence sources.

1.15 Research Methods/Processes

Exclusion Criteria

- Non-human studies, such as those that employ a model to demonstrate or test mHealth interventions.
- High-income countries are implementing mobile health interventions to help people with cancer.
- MHealth interventions are delivered through non-mobile communication devices or wireless technologies, such as desktop computers, as well as facility-based telemedicine.
- Other disorders, such as chronic or communicable diseases, are being researched with the help of mobile health interventions.

Inclusion Criteria

The inclusion criteria used are: first, include studies addressing mHealth interventions with focus on cancer patients, second, include studies based on empirical methodologies like randomized control trials (RCTs), quasi-experimental designs (pre-post studies), qualitative and quantitative studies, and third, include only full text articles published in peer reviewed international journals in English language.

1.16 Sample method/Technique and Sample size

The interventions will be detailed using the Free et al method, which additionally groups participants by device (mobile phone, PDA, and modality) (for instance, SMS, text messaging, multimedia message) (Free et al., 2010).

1.17 Data collection instruments

The following information is extracted using a data extraction form: (1) the study's location; (2) the type of participant/study population/demographic characteristics (e.g., women aged 18 and older); (3) the type of mHealth device used (e.g., mobile phones, PDAs, smartphones, tablets); (4) the method of communication (e.g., voice call, SMS, MMS, Unstructured Supplementary Service Data, and Web); and (6) any discrepancies. The third author will function as a mediator if no agreement is achieved. Missing data will be requested by email by the study authors. If the study authors do not respond, we will attempt to impute missing data. It is suggested that standard deviations or standard errors be calculated using data from other similar studies in the review that used similar techniques and sample sizes. (Wiebe et al, 2006).

1.17.1 Data collection/fieldwork

Data will be collected and extracted using a standardized form adopted from research by Tokosi, Fortuin and Douglas (2017). Data will be extracted using a present template from the complete texts of selected abstracts. Always extract the following vital information: Names of the authors and the year of the study, type of participant/study population and demographic characteristics, type of mHealth device used (eg, mobile phones, PDAs, smartphones, tablets), type of intervention (eg, SMS, MMS, video, text, audio), nature of the mHealth intervention (eg, awareness, diagnosis, treatment), study type (randomized, nonrandomized), type of outcome assessed, and results. The information by Saidi, Fortuin and Douglas (2018) will be submitted to Version 5.3 of the Review Manager Software, in instructed (Considering the limitations). All writers will check the data for missing or erroneous information. If the authors are unable to reach an agreement regarding the lack of data entry, a neutral third person will be contacted to act as a mediator. The study's authors will send an email requesting any missing data (Free et al., 2013). If the study's authors

do not respond, information from other similar research included in the review that employed same techniques as well as sample sizes used to assign a missing value to standard deviation, Standard error values are abbreviated as (SD) by Wiebe, Vandermeer, Platt, Klassen, Moher, and Barrowman (2006).

1.18 Data coding and analysis

1.18.1 Data Analyses

According to the Centre for Reviews and Dissemination, a descriptive synthesis will be performed (Tacconelli, 2010). Text and tables will be utilized to summarize the features of the included research; it will consist of major data collection aspects (e.g., Authors, journal, and study type are all factors to consider when conducting research). For continuous outcomes, mean differences and standard deviations will be calculated. For dichotomous results, ratios, and 95% confidence intervals will be calculated.

The participants, interventions, and outcomes of each research will be documented and assessed for heterogeneity. Data will be gathered and pooled, and a meta-analysis is going to be performed if the data is comparable enough. If there is lot of difference between studies, the data will not be combined, and instead a summary of a story be performed. To collect data and execute the meta-analysis, Review Manager (RevMan version 5.4.1) will be used as the statistics program. Heterogeneity is measured using the I-squared (I^2) test., is a statistical review for heterogeneity that enables the evidence's quality to be assessed (Higgins & Green, 2008). If applicable an examination of subgroups will be conducted to see if different health apps affect women's breast cancer awareness and screening. Age groupings and geographic regions will be considered subgroups in this analysis.

1.19 Assessing Risk of Bias

Two writers will independently assess the possibility of prejudice based on International Joint Partnership recommendations (Higgins & Green, 2008). Randomization sequence creation, treatment assignment concealment, participant blinding, insufficient data on outcomes, selective reporting of outcomes, and other forms of prejudice are among these criteria. These criteria will be used to assess all

listed studies for bias. A brief explanation will be included with each score. Conflicts between reviews writers about the possibility of bias in individual Investigations will be made, if necessary, add a third author (Free et al., 2013).

1.20 Collating, Summarizing and Reporting the Results

Results from several sources research will be collected in a specific order, the content is numerically evaluated and thematically analysed, and the establishment of data and breadth has been identified in a narrative form (Arksey & O'Malley, 2005). Results obtained from methodological detail came back negative because of criticism (Levac, Colquhoun & O'Brien, 2010). As a result, present the results in a methodical and thorough manner, this review should adhere to the three distinct steps suggested by Levac et al. (2010). Qualitative summary analyses the thematic analysis and data, the steps were included in reporting the research results and findings by charts. Highlighting the evidence through strengths and gaps in research, it aims to provide context for future thinking about how best to improve patient outcomes. The data from each research will be examined to determine if there are any trends that emerge from the data. The examined SPSS version 21 is performed according to the numerical content of each research patterns from the emerging evidence. Findings will be presented as tables and charts, as well as a narrative account.

1.21 Ethical consideration

Neuman (2014) identified informed consent and participants' right to privacy as two sets of standards that should be followed to achieve the study's goal and objectives. The ethical consideration for this study will be the researcher's application to the relevant academic institution for permission to conduct the study. The researcher will apply to the CPUT ethics committee for permission to conduct this study, and once approved, the study will begin. Because no human participation is required, no harm should befall any human subjects.

1.22 Outline of the dissertation

The following is how the dissertation is organized:

Chapter One: sets the stage for a systematic assessment of mobile health (mhealth) initiatives for breast cancer screening and awareness in the second chapter. The study's goal and objectives are also included.

Chapter Two: examines the available literature about study. It contextualizes breast cancer and summarizes its global prevalence. The review delves into the literature on health as a tool for providing health solutions.

Chapter Three: the study's systematic review methodologies are described in this section. It covers topics including eligibility criteria, search method, data extraction, and research selection, as well as risk of bias assessment, data analysis, and synthesis. It offers methods for dealing with incomplete data and determining heterogeneity.

Chapter Four: summarizes the systematic review's findings, including study selection, study characteristics, study risk of bias, and individual study outcomes.

Chapter Five: The findings and limitations of the study are discussed. It also considers the ramifications of the findings. It also contains a conclusion and future study recommendations on the use of health in breast cancer.

1.23 Limitations of the research

This scoping review has several advantages, including the fact that it is the first to examine health evidence in the context of cancer in LMICs. As a result, the findings are useful in furthering specific field in the state of knowledge. The key strength of thoroughness with the literature was searched using the It was decided on relevant search phrases for databases and grey literature sources. The extensive search yielded a diverse set of study designs that yielded broad results. This scoping review, on the other hand, discovered some flaws. It was tough to construct a data extraction form due to the diversity of investigations. Each study must produce a summary of complicated concepts, which must be extracted in a more consistent and relevant manner.

CHAPTER 2: LITERATURE REVIEW

This review includes all research on the use of mHealth interventions to assist with breast cancer care. The past and present state of cancer will be discussed, as well as emerging trends. The literature gaps concerning breast cancer types will be identified and explained.

2.1. Cancer

Cancer is a disease in which certain cells in the body grow uncontrollably and spread to other parts of the body. Cancer can develop almost anywhere in the human body, which contains trillions of cells. Human cells normally grow and multiply (a process known as cell division) to form new cells as the body requires them. Cells die when they become old or damaged, and new cells replace them. When this orderly process fails, abnormal or damaged cells grow and multiply when they should not. These cells can combine to form tumours, which are tissue lumps. Tumours may or may not be cancerous (benign). Cancerous tumours invade nearby tissues and can travel to distant parts of the body to form new tumours (a process called metastasis). Cancerous tumours are also known as malignant tumours. Many cancers form solid tumours, but blood cancers, such as leukaemia, do not. Benign tumours do not invade or spread into nearby tissues. When benign tumours are removed, they usually do not recur, whereas cancerous tumours occasionally do. However, benign tumours can grow to be quite large at times. Some, such as benign brain tumours, can cause serious symptoms or be fatal.

2.2. Types of cancer

2.2.1 Breast Cancer

Breast cancer has become the most common type of cancer among women worldwide in recent decades. It is a complicated disease with environmental, genetic, and lifestyle risk factors. Breast cancer is a clinically diverse group of diseases that range in severity from indolent to aggressive. Breast cancer epidemiology differs significantly between populations (Ferlay, Soerjomataram, Dikshit, Eser, Mathers & Rebelo, 2015). African American women have been shown to be three times more likely than Caucasian women to develop highly aggressive triple-negative and inflammatory breast cancer (Chalabi et al., 2008). Furthermore, several studies have

shown that high rates and long histories of consanguinity, as seen in some upper-income Asian and other countries, reduce the frequency of mutations on the two major susceptibility genes, BRCA1 and BRCA2 (Mahfoudh et al, 2012, Medimegh et al, 2015).

2.2.2 Prostate Cancer

Prostate cancer is a common malignancy among men and possibly the third most aggressive neoplasm worldwide, claiming approximately 90,000 lives in Europe each year. Over the last few decades, international guidelines for the management of prostate cancer cases have become more conservative. The most common interventions are prostatectomies and/or external beam radiotherapy, followed by androgen deprivation therapy (ADT) maintenance, also known as chemical castration. A combination of next-generation endocrine therapies such as enzalutamide and the cytotoxic agent docetaxel is the standard of care in prostate cancer. New promising treatments for this cancer include radium-223 for bone metastases, pembrolizumab as immunotherapy (PDL1 blocker) for microsatellite instability (MSI) disease, and poly ADP ribose polymerase (PARP) inhibitors for those with mutations in homologous recombination genes, most commonly BRCA2. Other than age, few risk factors have been characterized. The best known include smoking (Plakson et al, 2003, Kenfield et al, 2011), obesity (Porter et al, 2005) and genetic predispositions

2.2.3 Cervical Cancer

Cervical cancer is the fourth most frequent cancer in women with an estimated 604 000 new cases in 2020. Of the estimated 342 000 deaths from cervical cancer in 2020, about 90% of these occur in low- and middle-income countries. In comparison, cervical cancer accounts for less than 1% of all cancers in women in high-income countries (Arbyn, Weiderpass, Bruni, de Sanjosé, Saraiya & Ferlay, 2020). Cervical cancer, the only cancer that, if detected early, is nearly entirely preventable and curable, primarily affects middle-aged women (30 to 50 years) (Moyer, 2012). It is caused by sexually transmitted infections with certain Human papillomaviruses (HPV), which are a type of virus that causes cervical cancer (Lei et al., 2020). Two HPV types, 16 and 18, are responsible for roughly 70% of cervical cancer cases and pre-cancerous cervical lesions worldwide. There is also evidence that HPV is linked to anus, vulva, vaginal, penis, and oropharyngeal cancers. In many countries around

the world, three HPV vaccines are now available: a bivalent vaccine, a quadrivalent vaccine, and a nonvalent vaccine. All three vaccines are highly effective against HPV types 16 and 18. Furthermore, the vaccines are extremely effective at preventing precancerous cervical lesions caused by these virus types. The WHO national HPV immunization program is implemented in most Eastern and Southern African countries. Libya is the only country in North Africa using this vaccine to prevent cervical cancer. The only three Western African countries included in this program are Ivory Coast, Gambia, and Senegal. However, no HPV vaccinations have been reported in Central Africa.

2.2.4 Lung Cancer

Lung cancer, which has been the most common cancer in the world for decades, saw approximately 2.1 million new cases in 2018 (Bray et al, 2018). It is a deadly cancer that kills more than 1.6 million people worldwide each year (Chan & Hughes, 2015). Upper-income countries have seen significant decreases in lung cancer mortality rates due to increased awareness of the harmful effects of smoking and other risk factors (Gaafar & Eldin, 2005). In contrast, lung cancer incidence and mortality rates have increased in some low- and middle-income countries (Gelband & Sloan, 2007). The main reason for this disparity is increased smoking (tobacco, water pipes, cannabis smoking, and passive smoking), as well as limited access to screening, diagnosis, and appropriate targeted therapies. Asbestos exposure, dust, fumes, nickel, silica, and insecticides have all been identified as risk factors. Some African countries have yet to prohibit or limit asbestos use (Gaafar & Eldin, 2005). Furthermore, as life expectancy rises in Africa, so does the risk of contracting and dying from lung cancer. Furthermore, numerous studies have identified genetic biomarkers in the EGFR, KRAS, and ALK genes to describe genetic susceptibility to lung cancer, particularly in North Africa (Dhieb et al., 2019).

2.2.5 Stomach Cancer

Stomach cancer is the sixth most common cancer worldwide, with 1,033,701 new cases reported in 2018. Eastern Asia was responsible for roughly half of these cases. It is also the third leading cause of cancer-related deaths worldwide, with a median overall survival of 9-16 months once metastatic (Fontana, Smyth, 2016). Risk factors for stomach cancer include a high salty and smoked food diet, a low fruit and vegetable diet, a family history of stomach cancer and polyps, long-term

stomach inflammation, pernicious anaemia, smoking, and Helicobacter pylori infection (H. pylori). H. pylori is a gastric pathogen that infects approximately half of the world's population. Infection with H. pylori causes chronic inflammation and increases the risk of developing duodenal and stomach cancer. The highest prevalence of H. pylori infection was found in Africa, at 70.1%, followed by South America and Western Asia, at 69.4% and 66.6%, respectively (Hooi et al., 2017). Furthermore, family histories of gastric cancer, Lynch syndrome, and familial adenomatous polyposis, as well as genetic mutations primarily on the CDH1 gene, are known risk factors for hereditary stomach cancer.

2.2.6 Colorectal Cancer

Colorectal cancer is Africa's sixth most common cancer (Parkin D, Bray, Ferlay, and Jemal., 2014). (Katsidzira et al, 2017) Most cases are metastatic and advanced at the time of diagnosis. As a result, fatality rates are high (Chalya et al, 2015). Diet, lifestyle, socioeconomic status, urbanization, Crohn's disease, and diabetes mellitus are all potential risk factors for colorectal cancer. Prior Schistosomiasis infection, while debatable, may also be a risk factor (Katsidziraet al, 2019). Furthermore, 5% of colorectal cancer cases may have underlying genetic predispositions from germline disorders like Lynch syndrome, familial adenomatous polyposis, and mutations in genes involved in the mismatch repair pathway (Lichtenstein et al., 2000). Hereditary factors may be more prominent in Africa, where 25% of affected people are under the age of 40 (Katsidzira et al, 2019), (Cronjé et al, 2009).

2.2.7 Esophageal Cancer

Esophageal cancer (EC) is the tenth most common cancer and the sixth leading cause of death worldwide. In 2018, there were 572,034 new cases reported worldwide, accounting for 3.2% of all cancers, with 28,494 (5.0%) from Africa (Bray et azl, 2018). Tobacco use and chewing (Asombang et al, 2016, Ocama et al., 2008) heavy alcohol consumption (Mchembe et al ,2013), drinking hot beverages (Middleton et al,2019), exposure to polycyclic aromatic hydrocarbons (PAH) (Abedi-Ardekani et al.,2010), consumption of red meat (Sewram et al, 2014), poor oral health (Abedi-Ardekani et al, 2010), low intake of fresh fruits and vegetables (Leon et al, 2017), and acid reflux are all risk factors for developing EC. Furthermore,

certain viruses, such as human papillomavirus, herpes simplex virus, cytomegalovirus, and Epstein-Barr virus, have been linked to EC development via oesophageal epithelial infection. EC frequently begins as Barrett's oesophagus, which may or may not progress to cancer. Barrett's Oesophagus is diagnosed early, monitored, and sometimes treated in Europe and North America. Most Africans do not have access to such early detection.

2.2.8 Liver Cancer

Liver cancer is the seventh most common cancer in the world, ranking fifth in men and ninth in women. It is Africa's fourth most common cancer, with some variations in prevalence and etiology between North and Sub-Saharan Africa. Despite well-known and avoidable risk factors, cancer mortality remains extremely high. Its IR has also been linked to high levels of viral infection as well as synergistic environmental risk factors. The human immunodeficiency virus (HIV) and viral hepatitis have both been linked to an increased lifetime risk of liver cancer. Furthermore, rapid urbanization has increased the prevalence of risk factors such as coinfection, aflatoxin exposure, iron overload, type 2 diabetes mellitus, and obesity.

2.2.9 Bladder Cancer

Bladder cancer is a serious health issue. There is mounting evidence that gene-environment interactions are linked to bladder cancer development. Tobacco use and occupational exposure remain the most hazardous risk factors (Cumberbatch, Jubber, Black, Esperto, Figueroa, Kamat, et al., 2018). Invasive bladder cancer is more common in smokers than in nonsmokers (Barbosa, Vermeulen, Aben, Grotenhuis, Vrieling, Kiemeney, 2018). Furthermore, cancer rates in workers who are exposed to chemical products, such as printers, hairdressers, and truck drivers, may be higher (Takkouche, Regueira-Méndez, Montes-Martnez, 2009). Other risk factors include birth defects in the bladder, a lack of fluids, the use of certain medications or herbal supplements, and chronic bladder irritation and infections. Mutations in the retinoblastoma, or RB1, gene, as well as mutations in PTEN, which have been linked to breast, thyroid, and Cowden disease, are among the genetic risk factors for bladder cancer. People who have Lynch syndrome are more likely to develop bladder cancer and other urinary tract cancers.

2.2.10 Thyroid Cancer

Thyroid cancer arises from the tissues of the thyroid gland (Cabanillas, McFadden, Durante, 2016). There were 298,000 new cases worldwide in 2012. In recent decades, incidence rates have risen, which is thought to be due to advances in diagnostics. There were 567,233 new cases and 41,071 reported deaths worldwide in 2018. Thyroid cancer is most common in people aged 35 to 65. (Howlader, Krapcho, Miller, Bishop, Kosary, Yu, et al., 2017). Several risk factors for thyroid cancer have been identified. Radiation exposure is one of the most studied and proven risk factors. Certain medical treatments, as well as radiation fallout from power plant accidents or nuclear weapons, are sources of such radiation. Other risk factors include being overweight and eating an iodine-deficient diet. Even though the genetic component of thyroid cancer is unknown, several hereditary forms of the disease have been identified, including:

- Thyroid cancer that runs in families (FMTC). FMTC can occur alone or in conjunction with other tumors caused by RET gene mutations.
- People with Familial adenomatous polyposis (FAP), which is known to cause many colon polyps and/or colon cancer, are also at a very high risk of developing papillary thyroid cancer.

- Cowden disease patients are more likely to develop thyroid problems and certain benign growths (including some called hamartomas). Thyroid cancers are classified as either papillary or follicular. PTEN gene mutations are the most common cause of this syndrome.
- People with Carney complex, type are more likely to develop benign tumors and hormonal issues. They are also more likely to develop papillary and follicular thyroid cancers. Mutations in the PRKAR1A gene cause this syndrome.
- Familial non-medullary thyroid carcinoma: these cancers are thought to be caused by genes on chromosomes 19 and 1.
- People with Carney complex, type I may develop benign tumors and hormonal problems. They are also predisposed to papillary and follicular thyroid cancer. Mutations in the PRKAR1A gene cause this syndrome.
- Familial non-medullary thyroid carcinoma: these cancers are thought to be caused by genes on chromosomes 19 and 1.

2.3. Breast Cancer

Every year, over 1.5 million women worldwide (25% of all cancer patients) are diagnosed with breast cancer (Stewart & Wild, 2014). Breast cancer is estimated to account for 30% of all new cancer cases (252,710) among women in the United States in 2017 (Siegel, Miller & Jemal, 2017).Early detection of the disease can result in a favourable prognosis and a high survival rate (Prorok et al, 1984). Because of timely detection of this disease, the 5-year relative survival rate of breast cancer patients in North America is greater than 80% (DeSantis, Fedewa, Goding Sauer. et al., 2015). Mammography is a widely used screening method for detecting breast cancer that has been shown to effectively reduce mortality. Other screening methods, such as MRI, which is more sensitive than mammography, have also been implemented and studied over the last decade (Drukteinis, Mooney, Flowers. et al, 2019).

Sex, aging, oestrogen, family history, gene mutations, and an unhealthy lifestyle are all risk factors that can increase the likelihood of developing breast cancer (Majeed, Aslam, Javed. et al., 2014). Women are 100 times more likely than men to develop breast cancer, and the number of cases in women is 100 times higher (Siegel, Miller, Jemal, 2017).

2.4. mHealth

mHealth refers to the use of telecommunication devices to support the health system and clinical practice (Kahn et al., 2010). It combines technological advancements with medical expertise to create new opportunities in critical areas of healthcare such as diagnostics, telemedicine, research, reference libraries, and interventions (Bastawrous et al., 2013). It is supported by mobile devices such as phones, patient monitoring devices, personal digital assistants, and other wireless devices (WHO, 2011). mHealth platforms include all computer and medical devices, as well as internet and mobile phone devices (Free et al., 2013).

By addressing healthcare delivery with mobile telecommunications and multimedia technologies, mHealth aims to bridge the accessibility gap between patients and health professionals. It may improve patient-provider communication, disease management, and health promotion (Beratarrechea et al., 2014). Mobile technologies, such as advanced mobile computing, can help health workers make

better decisions by facilitating immediate communication and providing access to information (Varshney, 2014). mHealth is defined as utilizing and capitalizing on a mobile phone's core utility of voice and SMS, as well as more complex functionalities and applications such as general packet radio service, third and fourth generation mobile telecommunications (3G and 4G systems), global positioning system (GPS), and Bluetooth technology (Thuemmler et al., 2018).

Mobile phone communication has been widely used to improve health-care delivery worldwide (Kaplan, 2006). In developing countries, mHealth is being used to address a shortage of healthcare workers (Beratarrechea et al., 2014). Despite bearing 24% of the world's disease burden, Africa only has 3% of the world's health professionals, according to statistics (Teke, 2017). WHO (2011) believes that mHealth has the potential to change the way health care is delivered globally. Recently, mHealth has proven useful in the control of the Zika virus by pinpointing outbreaks and assisting physicians in virus detection (Dudley et al., 2017), as well as in the fight against the Ebola virus (Dahiya and Kakkar, 2016). Message sent via text Smoking cessation (Fairhurst and Sheikh, 2008), increased attendance at primary care appointments (Gurol-Urganci et al., 2013), medication adherence improvement (Fairley et al., 2003), and chronic disease follow-up are among the 9 mHealth interventions (Ferrer-Roca et al., 2004). Test messaging has also been used to combat infectious diseases and promote health (Obermayer et al., 2004).

SMS reminders for paediatric cataracts improved follow-up attendance, proving to be a useful tool in controlling infant cataracts in China, according to Lin et al. (2012). Text messaging is the most popular form of interpersonal communication (WHO, 2011). SMS has been found to be cost effective and efficient in reaching the patient even when the phone is turned off or in areas where phone calls are not permitted (Kaplan, 2006). Furthermore, Balzer, Kelly, Hazell, Paxton, Hawke, and Steinbeck (2014) discovered SMS to be a viable tool for use as a reminder system.

2.5. mHealth and cancer

Several apps have been created specifically for breast cancer patients (Cruz, Vilela, Ferreira, Melo & Reis, 2019, Uhm, Yoo, Chung, Lee, Lee, Kim, et al, 2017). However, there is a paucity of synthesized evidence focusing specifically on the design and development of mHealth apps for breast cancer patients' care. As a result, this study maps recent literature on mHealth apps developed specifically for breast cancer patients and identifies the need for systematic efforts to develop and validate the apps.

2.6. Summary

mHealth apps have the potential to improve adherence among breast cancer patients. To capitalize on this future potential, app quality and app information must be urgently improved. It is currently extremely difficult for laypeople and doctors/other therapists to find high-quality apps. Guidance from independent or governmental institutions would be beneficial in advancing digitalization in health care. Patient characteristics, needs, and patient-reported outcomes data are critical components for developing breast cancer mHealth apps. Furthermore, patients, nurses, and other important health professionals should work together to develop mHealth apps for breast cancer care. More research is needed into the design and development of mHealth apps for breast cancer patients.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

This chapter describes the systematic review steps used in the study, which was guided by the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) The Prisma checklist is included as Appendix A at the end of this study.

3.1. Eligibility criteria for including studies

3.1.1 Study design

This review's study design will include both randomized and nonrandomized studies. Case-control, cohort, and cross-sectional studies in which mHealth was the primary intervention used for breast cancer awareness and screening will be included in the nonrandomized studies.

3.1.2 Study participants

Women aged 18 and over will be eligible to participate in the study. In the reviewed studies, women of all races, ethnicities, employment statuses, occupations, and roles will be eligible for inclusion.

3.1.3 Type of intervention

The study's relevant mHealth interventions should primarily aim to improve breast cancer awareness and screening. mHealth interventions have been developed for health care consumers (women 18 and older) to increase healthy behaviors (e.g., breast cancer awareness) or hospital attendance (e.g., increasing women's participation in hospital workshops to improve their understanding of early breast cancer detection, management, and treatment) (Free, et al, 2013, Kumar, Nilsen, Abernethy, Atienza, Patrick, Pavel, et al, 2013). The interventions will be described using the Free et al strategy, which divides them into device (mobile phone, PDA) and modality categories (e.g., SMS, text messaging, multimedia message service [MMS], video).

3.1.4 Outcomes

The impact of mHealth interventions on breast cancer awareness and screening will be assessed by reviewing: (1) increased attendance at breast cancer clinics; (2) the stage of breast cancer when diagnosed, as this would assist in determining whether

mHealth has promoted early detection and screening; and (3) increased breast cancer enquiries via call centers, online forums, and social media.

3.1.5 Study setting

The study's setting will not be restricted by geography. All continents, countries, and health facilities where breast cancer mHealth research has been conducted will be included. This method allows for the capture of all relevant information sources.

3.2. Search strategy

While Casson and Leder identified the first keyword "mobile health" in the literature in 1991 (Casson & Leder, 2013), relevant literature will be identified beginning in 1964. This start date corresponds to the first identifiable mention of the keyword "telemedicine" in a preliminary search of all major databases, including the Medical Literature Analysis and Retrieval System Online (MEDLINE), Excerpta Medica dataBASE (EMBASE), Psychological Information Database (PsycINFO), Cumulative Index to Nursing and Allied Health Literature (CINAHL), and The Cochrane Library (Cochrane Database of Systematic Reviews, Cochrane Central Register of. For reasonable analysis purposes, the publication language will be English only. Trial registers, SpringerLink, Wiley InterScience, Institute of Electrical and Electronics Engineers, Association for Computing Machinery Digital Library, and CiteSeer are among the other databases that will be considered within the scope and objectives of the study (Labrique, Vasudevan, Kochi, Fabricant, Mehl, 2013). For trial registers, the authors will identify ongoing studies as well as recently completed trials. The studies that will be included will be selected using predefined search terms that are specific to the databases that will be used.

To develop an optimal search strategy, the authors will adapt the experimental findings proposed by Fortuin et al (Fortuin, Salie, Abdullahi & Douglas, 2016) in identifying accurate search terms. As shown in Table 1, Key terms will be included in the search strategy (MEDLINE format). This format was developed with the assistance of a library sciences specialist and will be used for all future database searches. Table 1 shows the number of references found after conducting a preliminary search. The reference lists of the primary studies included in the review,

as well as the reference lists of relevant and previously published reviews, will be manually searched. Full-text articles culled from reference lists from studies will be reviewed. Using the same eligibility criteria, unpublished studies will be identified from universities and other databases.

Table 1. A preliminary search query classification

Number	Query	Items
#1	Search((((((((((mHealth) OR telemedicine) OR wireless technology) OR mobile phone) OR smartphone) OR cell phone) OR mobile technology) OR mobile device) OR mobile-based phone) OR tablet computer) OR IPAD) OR pda) OR mHealth application)) AND (breast cancer) OR neoplasm Filters: Publication date from 2008/01/01 to 2019/12/31)	421
#2	Search((((((((((((mHealth) OR telemedicine) OR wireless technology) OR mobile phone) OR smartphone) OR cell phone) OR mobile technology) OR mobile device) OR mobile-based phone) OR tablet computer) OR IPAD) OR pda) OR mHealth application)) AND (breast cancer) OR neoplasm Filters: Publication date from 1964/01/01 to 2016/12/31))) AND (((((awareness) OR education) OR promotion)) Filters: Publication date from 2008/01/01 to 2019/12/31)	88
#3	Search((((((((((((((mHealth) OR telemedicine) OR wireless technology) OR mobile phone) OR smartphone) OR cell phone) OR mobile technology) OR mobile device) OR mobile-based phone) OR tablet computer) OR IPAD) OR pda) OR mHealth application)) AND (breast cancer) OR neoplasm Filters: Publication date from 1964/01/01 to 2016/12/31))) AND (awareness) OR education) OR promotion)) AND ((screening) OR diagnosis) Filters: Publication date from 2008/01/01 to 2019/12/31)	52

3.3. Data extraction

A data extraction form will be used to extract the following key information, (1) the country of study setting; (2) the type of participant/study population/demographic characteristics (e.g., women aged 18 years and older); (3) the type of mHealth device used (e.g., mobile phones, PDAs, smartphones, tablets); (4) the method of communication (e.g., voice call, SMS, MMS, Unstructured Supplementary Service Data and Web); (5) the nature of the mHealth. If any discrepancies are discovered while extracting data, the first two authors will discuss them. If no agreement can be reached, the third author will mediate. Missing data will be requested via email from

study authors (Free, Phillips, Galli, Watson, Felix, Edwards, Patel, Haines, 2013). If we do not receive a response from the study authors, we will attempt to impute missing standard deviations or standard errors using data from other similar studies in the review, using similar methods and sample sizes, as Wiebe et al. recommend (Wiebe, Vandermeer, Platt, Klassen, Moher & Barrowman, 2006).

3.4. Study selection

The first author will retrieve all relevant articles from the various databases based on the finalized search strategy. Reference management software will be used to save the collected literature. Two contributing researchers will review the titles and abstracts of the retrieved studies to determine their eligibility. The full text article will be used by these researchers to make the final decision on inclusion, and any discrepancies or disagreements will be resolved by the third researchers.

3.5. Assessing risk of bias

These criteria include the generation of randomization sequences, the concealment of treatment allocation, participant blinding, incomplete outcome data, selective outcome reporting, and other sources of bias are all potential sources of bias. All included studies will be evaluated for bias using these criteria. A descriptive summary will accompany each score. Disagreements among review authors about the risk of bias in specific studies will be resolved through dialogue, with the participation of a third researcher if necessary (Free, et al, 2013).

3.6. Dealing with missing data

Missing data from relevant trials will be identified, and the articles compared to published trial reports. Any discrepancies were resolved by contacting the articles original authors, if they did not respond, incomplete data will be discussed.

3.7. Data analysis and synthesis

In accordance with the Centre for Reviews and Dissemination (Tacconelli, 2010), a descriptive synthesis will be conducted. Text and tables will be used to summarize the characteristics of the included studies, which will include the primary data extraction components (e.g., study setting, authors, journal, and study type).

Mean differences and standard deviations for continuous outcomes will be computed. Ratios and 95% confidence intervals will be computed for dichotomous outcomes. To determine heterogeneity, each study's participants, interventions, and outcomes will be examined. Data will be collected and analysed if they are sufficiently similar. If study variability is high, the results will not be pooled, and a narrative synthesis will be performed instead.

To collect data and perform the meta-analysis, the statistical software Review Manager (RevMan version 5.4.1) will be used. The I-squared (I^2) test, which quantifies heterogeneity, is included in the statistical test for heterogeneity; this test will allow the quality of the evidence to be validated (Higgins & Green, 2008). A subgroup analysis will be used when necessary to determine whether different mHealth applications influence breast cancer awareness and screening among women, and if so, in what context. For this analysis, age groups and geographical regions will be considered subgroups. Several sensitivity analyses will be carried out. The first sensitivity analysis will be performed based on the study quality to investigate potential sources of heterogeneity (risk of bias and level of participant dropout). The second analysis will investigate how excluded studies may have influenced the overall result. The third analysis will investigate how the outcomes would differ if only high-quality studies were included (Higgins & Green, 2008).

3.8. Assessment of heterogeneity

Clinical heterogeneity was assessed by looking at the different types of participants, interventions, and outcomes in each study. The studies that were identified as clinically homogeneous were pooled. To assess study heterogeneity, Chi-square tests and I-squared statistics were used. We quantified any statistical heterogeneity between study results using the I2 statistic. If the I2 was greater than 50%, we considered heterogeneity to be significant (Higgins 2011).

3.9. Ethics approval

There was no need for ethics approval because the study did not involve human participants.

CHAPTER 4: INTERPRETATION OF DATA

The results of the systematic review are presented in this chapter.

Description of the studies

4.1. Result of the search

From the searches in the literature, 52 studies were found. From the grey literature and the World Wide Web, fifteen studies were obtained. After removing five duplicates, 47 articles were reviewed, resulting in the exclusion of seventeen studies. Thirty full-text articles were reviewed for eligibility, and fifteen were rejected with explanations. The synthesis also included fifteen studies. Figure 1 depicts the steps for selecting which studies were included and which were excluded.

PRISMA DIAGRAM

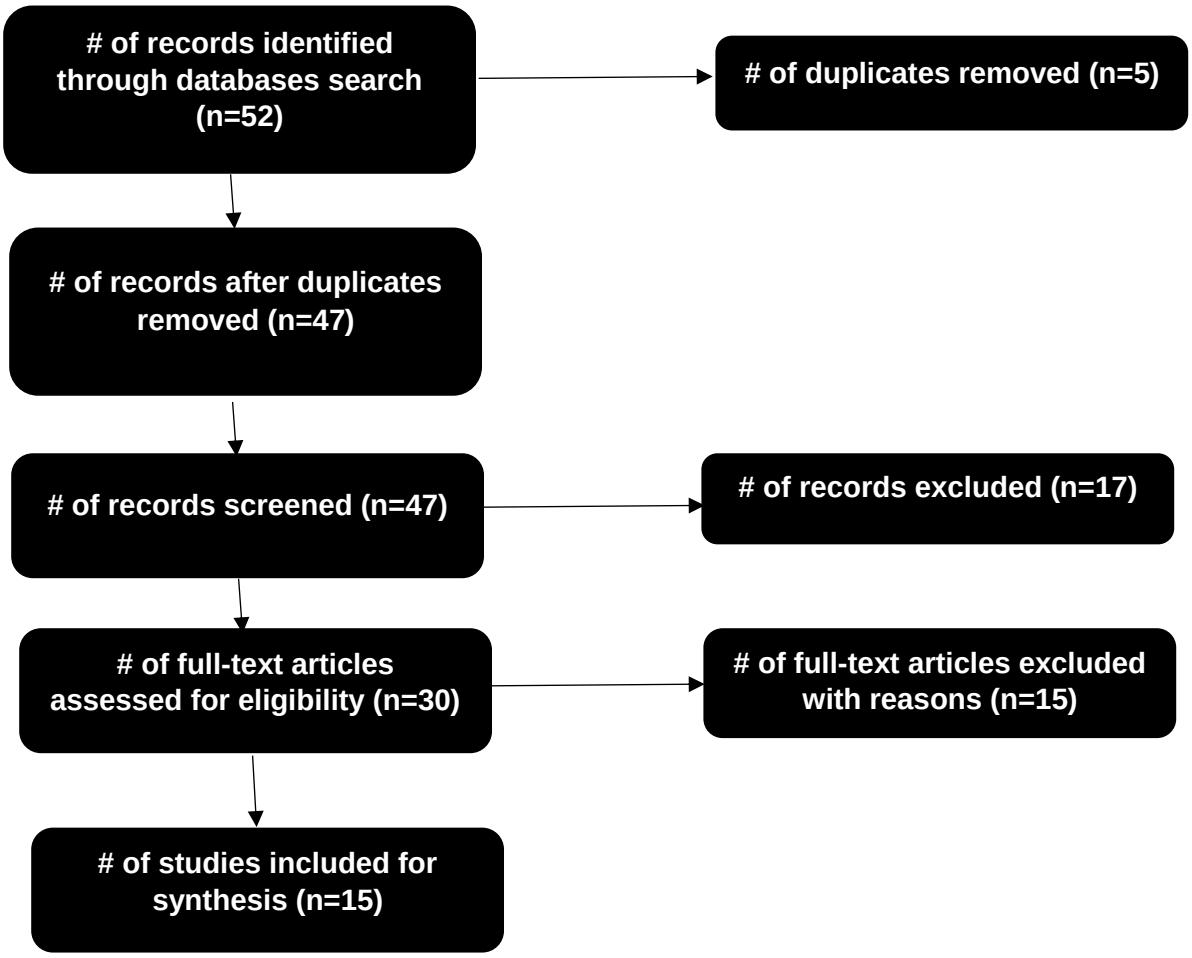

Figure 1. Visual representation of the study selection

4.1.1. Effectiveness of interventions

According to current evidence, mHealth interventions improve cancer disease management by improving symptoms, QoL, and wellbeing, increasing attendance rates, and improving cancer therapy adherence (Marcolino Oliveira, D'Agostino, Ribeiro, Alkmim, & Novillo-Ortiz, 2018). Lee et al. (2018) demonstrated the use of a novel wearable technology pedometer that converts breast cancer patients' self-reported exercise to direct measurement using new technology (Lee et al.,2018), Many studies on mHealth interventions investigated the effectiveness of interventions in improving the health self-efficacy of breast cancer patients. (Fu et al., 2016, Zhu, Ebert, Xue, Shen & Chan, 2017, Chow et al., 2019, Lee et al., 2018, Ainsworth et al., 2018). Six additional interventions were discovered to improve cervical cancer screening and management (Bhatt et al., 2018, Erwin et al., 2019, Moodley et al, 2019, Momany et al., 2017).

4.1.2. Included studies

The systematic review included 15 articles addressing various cancer disease intervention types, with each study providing a detailed overview of mHealth interventions. The researchers found that 5 (9.6%) of the 15 included studies dealt with cervical cancer awareness, screening, and management. All 17 (32.7%) mHealth interventions were evaluated for breast cancer awareness, prevention, early detection, and care management. Five studies (9.6%) focused on colorectal cancer screening, one study (1.9%) on dermatological cancer screening, two interventions (3.8%) on lung cancer health promotion, four studies (7.7%) on pain management for children undergoing cancer treatment, four studies (7.7%) on oral anti-cancer medication adherence, and fourteen studies (26.9%) looked at the impact of mHealth interventions on self-regulation for QoL in cancer patients and survivors. The following are the inclusion criteria: first, studies addressing mHealth interventions with a focus on cancer patients and survivors are included; second, studies based on empirical methodologies such as randomized control trials (RCTs), quasi-experimental designs (pre-post studies), qualitative and quantitative studies are included; and third, only full-text articles published in peer-reviewed international journals in English are included.

4.1.3. Excluded studies

The preliminary screening was based on titles and abstracts, which were independently evaluated. If the abstract did not provide enough information, the full-text publications were retrieved. Following that, three independent investigators evaluated full-text articles and determined each manuscript's eligibility. The authorship, journal, or years were not in any way obscured. The Mendeley reference management software was used to manage the referencing of the selected studies. The following studies were excluded: first, studies on mHealth interventions related to behavioral change; second, literature reviews, protocols, books, and conference papers; and third, duplicate articles.

4.2 Study Characteristics

4.2.1 Study Participants

In a study conducted by Ali, Leow, Chew, and Yap (2018) to assess patients' perceptions of using an app to track oral anti-cancer medication adherence, many participants expressed interest in using the app. The mHealth supportive care intervention "Android smartphone app care assistant" addressed the social, emotional, and care needs of parents caring for children with acute lymphoblastic leukemia (Wang et al., 2018). Pain Buddy, an animated avatar-based tablet app developed using cutting-edge software, improved pain management and quality of life for children with cancer (Fortier, Chung, Martinez, GagoMasague, & Sender, 2016). Twenty-six (26) adolescents and young adults (AYAs) recently finished cancer treatment, and they used an SMS intervention that improved AYAs survivors of childhood cancer and decreased AYA survivors' responsiveness to text messages, resulting in higher engagement with prompt and personal messages (Casillas et al., 2017, Psihogios et al, 2019).

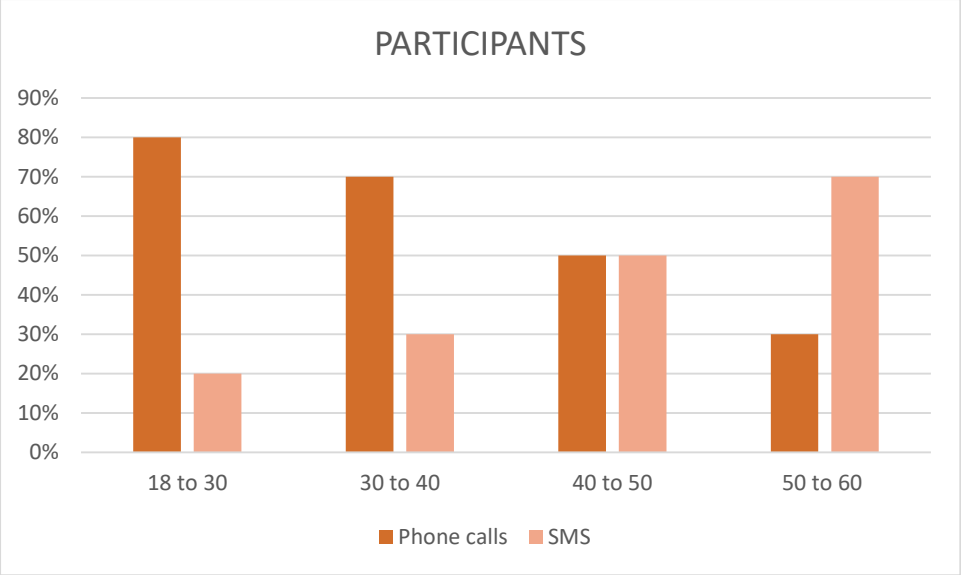

Figure 2. Age distribution of study participants per mHealth modality

4.2.2 Interventions

According to current evidence, mHealth interventions improve cancer disease management by improving symptoms, QoL, and wellbeing, increasing attendance rates, and improving cancer therapy adherence (Marcolino et al., 2018). According to Lee et al. (2018), the most popular mHealth intervention for improving QoL was behavior change via a mobile app and subsequent SMS text messaging. The use of a novel wearable technology pedometer has been demonstrated, which converts breast cancer patient exercise self-report to direct measurement via new technology. (Lee et al, 2018). Many studies on mHealth interventions investigated the effectiveness of interventions in improving the health self-efficacy of women with breast cancer (Fu et al., 2016, Zhu et al., 2017, Chow et al., 2019, Lee et al., 2018, Ainsworth et al., 2018). Six new interventions for cervical cancer screening and management have been identified (Bhatt et al., 2018, Erwin et al., 2019, Moodley et al, 2019, Momany et al., 2017).

4.2.3 Outcome measures

Various outcome measures were used in the studies. For example, the interventions' usability, emphasizing self-regulation for QoL, improving healthy lifestyles, cancer screening, pain management, symptom relief, and increasing adherence to oral cancer therapy. The usability of interventions such as text messages on mobile

phones, platforms, and apps (Bhatt et al., 2018, Fu et al., 2016, Erwin et al., 2019, Zhu et al., 2017, Chow et al., 2019, Lee et al., 2018, Momany et al., 2017), cross-sectional surveys (Ali et al., 2018, Kessel, Vogel, Schmidt-Graf & Combs, 2016, Raghunathan et al, 2018), phone interviews (Phillips et al., 2019, Nielsen et al., 2019, Drott et al, 2016, Sundberg et al, 2017), and focus groups was the primary focus of qualitative findings (Weaveret al., 2015). The primary outcomes assessed were behavioral or lifestyle changes (for example, physical activity promotion, mood, QoL promotion, social and emotional support, weight management), clinical outcomes (for example, cancer management, screening, BMI, pain reduction, symptom relief), and process of care (e.g., cancer therapy adherence, counselling, attendance rate follow-up, person-cantered care, survivorship care). Secondary outcomes included cost effectiveness and patient satisfaction.

Table 2. Study Characteristics

Study ID	Study design, Country, Device	Sample size	Age groupings	Interventions	Outcomes
Alanzi et al (2018)	RCT, Saudi Arabia, Mobile phone	200 participants	2 age groups ≤35 years ≥36 years	Control group did not receive any awareness materials intervention group received awareness materials	Increased awareness achieved by using Snap Chat among the participants of the intervention group
Thackeray, Burton, Giraud-Carrier, Rollins & Draper (2013)	Cross-sectional survey, USA, computer	1351823 participants	Adults < 30 years old	Social networking site Twitter for cancer awareness and community building.	Celebrities were found to be dominant in tweets and their tweets were frequently retweeted. Majority of tweets were not for preventive action.
Moodley, Constant, Botha, van der Merwe, Edwards & Momberg (2019)	Cross-sectional survey, South Africa, Mobile phone	364 women	Information not provided	SMS interventions for receiving Pap smear results and appointment reminders	SMS text-based messaging were perceived positively by most of the women
Buneviciene,	Systematic	957 patients	17 years to	mHealth	mHealth interventions

Mekary, Smith, Onnela & Bunevicius (2021)	review, no specific location, no device specified		69 years.	applications added to app stores each day	were found to have the potential for improving the quality of life for cancer patients
Alshawwa & Assiri (2020)	Systematic review, no specific location, no device specified	112196 participants	Information not provided	Mobile text messages, platform, and apps	mHealth strategies were found to have a positive impact on cancer survivors and caregiver teams and families
Langius-Eklof, Crafoord, Christiansen, Fjell & Sundberg (2017)	Systematic review protocol, no location, mobile technology	142 people	Information not provided	Smartphone, computer tablet app	Allows for person centered intervention and cancer problem identification and promotion of timely initiation of necessary treatment
Scholz & Teetz (2022)	Review, Germany, mobile technology	Information not provided	3 Age groups 50 Onwards 65 – 69 years 70 years	(Google Play Store/Android; App Store/iOS	mHealth apps were found to have the potential to support the adherence of breast cancer patients
Salmani, Ahmadi & Shahrokhi (2020)	Systematic review, no location, mobile technology	Information not provided	Information not provided	Smartphones and mHealth applications	Healthcare application users were found to have higher satisfaction of living and it leads to improved quality of life.
Błajda, Barnas & Kucab (2022)	RCT, Poland, mobile phone	500 women	Two groups of females and males >18years	Mobile medical app	Educational mobile medical apps for breast cancer prevention were found to be helpful in dealing with breast cancer prevention
Lee, Koopmeiners, McHugh, Ravies & Ahluwalia. (2016)	Quasi-experimental, USA, mobile phone	30 participants	Females aged 20-29 years	Mobile phone text messaging	Mobile health technology was found to be a promising tool in reducing the cancer burden for underserved populations.
Latif, Rana, Qadir, Ali, Imran & Younis (2017)	Descriptive study, Pakistan, mobile phones.	No information	Children and adults of all ages	SMS messaging	mHealth was found to offer significant opportunities for developing countries with a severe scarcity of health infrastructure and resources.

Lee, Lee, Gao & Sadak (2018)	RCT, USA, Mobile phone	120 women	40 to 77yrs	Multilevel and multimedia messages through a mobile phone app along with health navigator services	Mobile phone app–based intervention combined with health navigator service was a feasible, acceptable, and effective Intervention mechanism to promote breast Cancer screening
Kapoor, Nambisan & Baker (2020)	Systematic review, no location, mobile technology	Information not provided	Information not provided	Google Play (Android) and Apple App Store (iOS)	Symptom tracking; survivorship education; information-sharing with family and/or caregivers; scheduling follow-up visits; personal alerts and reminders; and social networking were associated with the mHealth apps. Survivorship education was found to be the most common self-management feature among the apps reviewed, followed by social networking.
Davis & Oakley-Girvan (2016)	Evaluation review, USA, mobile technology	No specific information	No specific information	Text messages	Smartphone applications have the potential to improve the cancer survivorship experience, but users should look for evidence that the application was appropriately developed and tested.
Ginsburg, Chowdhury, Wu,Chowdhury,Pal,Hasan, Khan, Dutta,Saeem, AlMansur, Mahmud,Woods, Story & Salim (2014)	RCT, Bangladesh, Smart phone	22 337 participants	3 age groups 25 to 34 35 to 44 45 +	Smart phone-empowered community health worker (CHW) model of care for breast health promotion	CHWs guided by smart phone applications were more efficient and effective in breast Health promotion compared with the control group

4.3 Risk of bias in included studies

A Cochrane risk of bias tool was used to assess the risk of bias in four RCTs. Figure 3 depicts the risk of bias in these four studies.

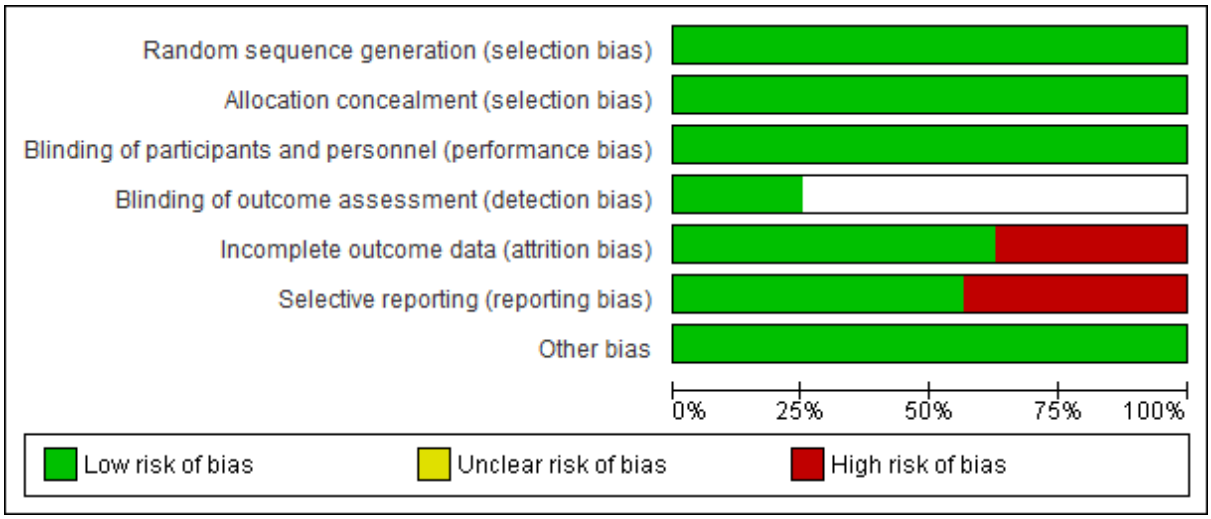

Figure 3. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies

4.4 Allocation

Only six studies explicitly stated that allocation in terms of allocation was concealed (Gustafson et al., 2014, Laing et al, 2014, Carter et al, 2013, Cheung et al, 2015, Lyu et al, 2016). However, eight studies failed to address allocation concealment adequately. Participants in four studies were blindfolded (Carter et al, 2013, Cheung et al, 2015, Glynn et al, 2014, Tighe et al, 2017). However, due to the nature of mHealth apps, some studies could not be conducted blindly. The remaining 15 studies were either not blinded or did not provide specific information about blinding in their reporting.

4.5 Blinding

Three of the studies in this review reported outcome assessment blinding (Carter et al, 2013, Heung et al, 2015, Glynn et al., 2014). In terms of reporting bias, 9 studies were deemed to have a low risk of bias, while 11 were deemed to be unclear on the presence of bias. The risk of bias table from Cochrane is summarized in (Figure 2).

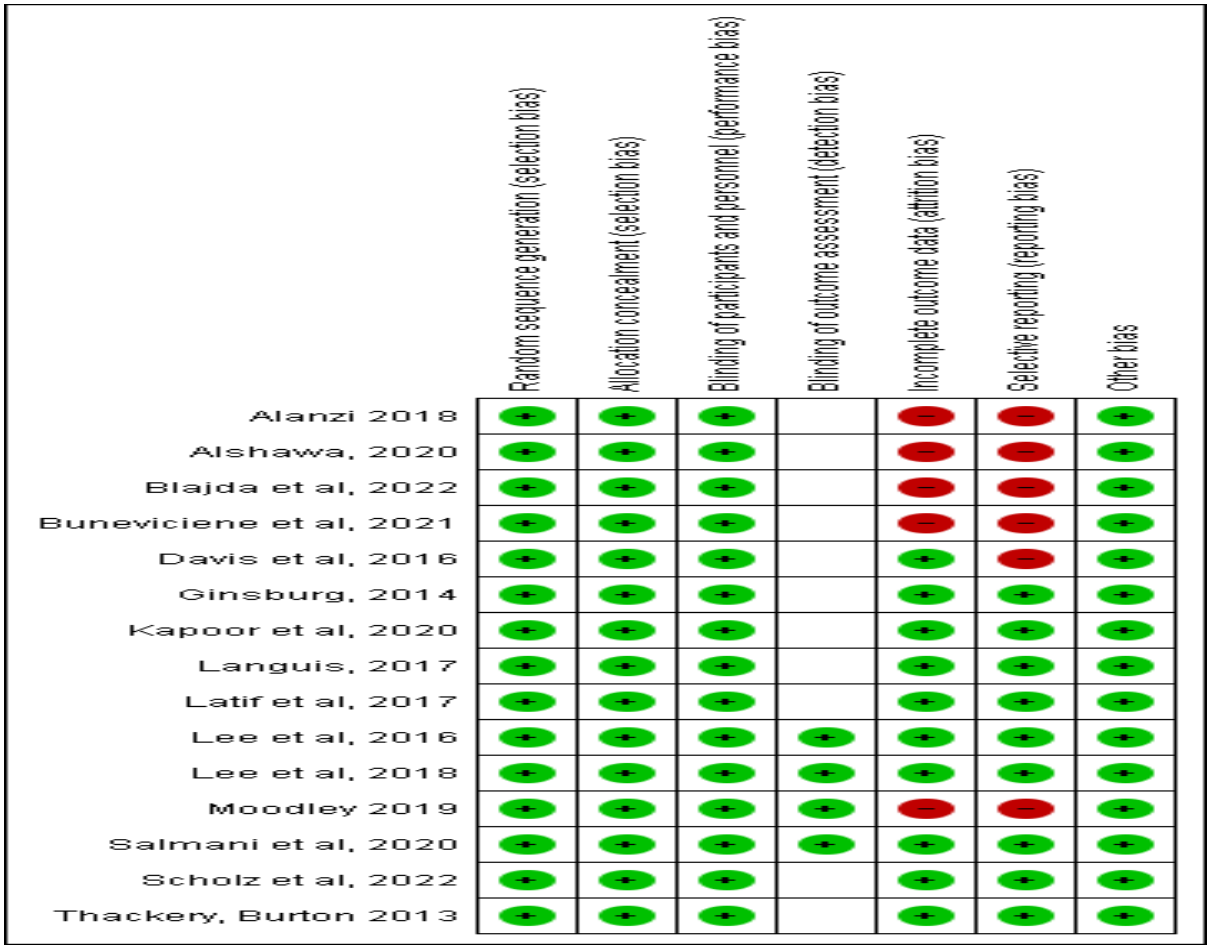

Figure 4: Risk of bias summary: review authors' judgements about each risk of bias item for each included study

4.5.1 Content Characteristics of Apps

Some app characteristics of contents were classified as providing information, planning (goal setting), reminding, providing feedback, or monitoring, according to Abraham and Michie's behavior change technique taxonomy. This study also discovered new app features such as data entry, education/training, and communication. Ten (10) apps with a variety of functions for managing health-related behaviors are available. Education or training is the most common function of mHealth apps.

4.5.2 Incomplete outcome data (attrition bias)

The risk of attrition bias was low in two of the studies, while it was high in the other two. One RCT study on breast cancer included many cancer patients, making it impossible to determine whether there was a significant improvement in outcomes.

4.5.3 Selective reporting

Three studies found the risk of selective reporting to be low, while one study found the risk to be unclear. According to the study's method, one particular outcome was not reported in the results.

4.5.4 Other sources of bias

There were no other potential sources of bias because none of the studies found evidence of potential sources of bias.

4.6. Results of individual studies

Effect of the interventions

4.6.1 Effect of SMS messaging compared to conventional awareness.

Analysis of two RCT studies (Alanzi et al, 2019, Ginsburg et al, 2014), shows the improvement on women with breast cancer awareness that had been used as conventional methods as seen in Figure 5.

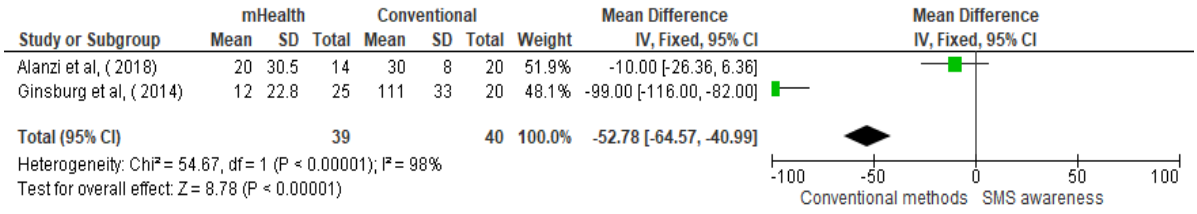

Figure 5. Analysis of 2 RCTs that shows the effect of SMS awareness

One cross-sectional study shows that SMS messaging is different when compared to conventional methods. According to the study SMS has useful impact when used as text messaging awareness in women with breast cancer as seen in Figure 6.

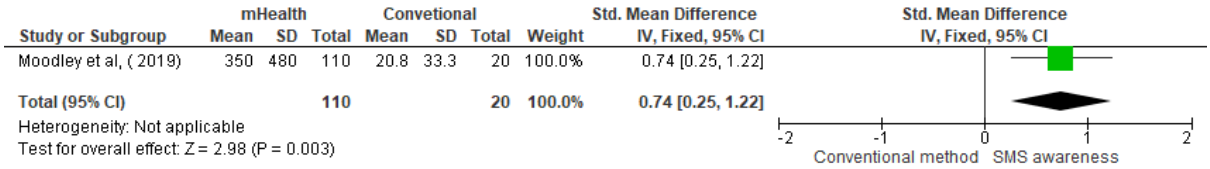

Figure 6. Analysis of a cross sectional study shows the effects of SMS awareness in breast cancer

Analysis of RCT study (Bladja et al, 2022), shows that the SMS messaging has no improvement on the SMS text group compared to conventional methods when used as awareness of breast cancer as seen in Figure 7.

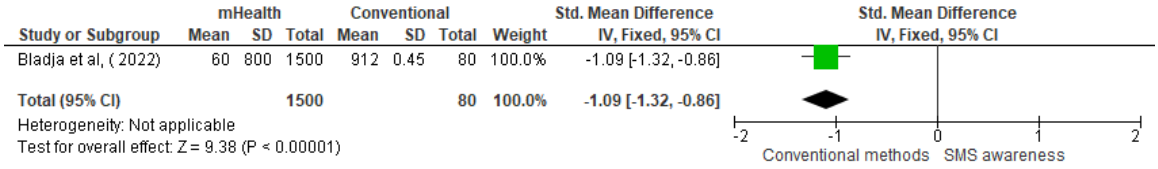

Figure 7. Analysis of RCT study shows the effect of SMS awareness in breast cancer screening

Analysis of a cross-sectional study (Davis & Oakley, 2016) shows that the SMS messaging had no improvements on the breast cancer awareness compared to conventional methods as seen in Figure 8.

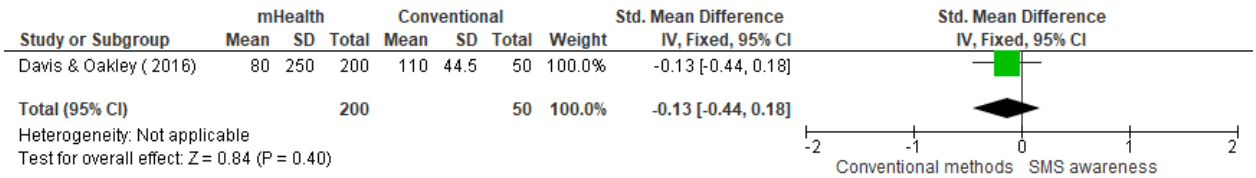

Figure 8. Analysis of a cross sectional study shows the effect of SMS awareness in women with breast cancer

Analysis of a non-RCT (Languis et al, 2017) shows that the text intervention has very slight improvement among breast cancer awareness compared to conventional methods as seen in Figure 9.

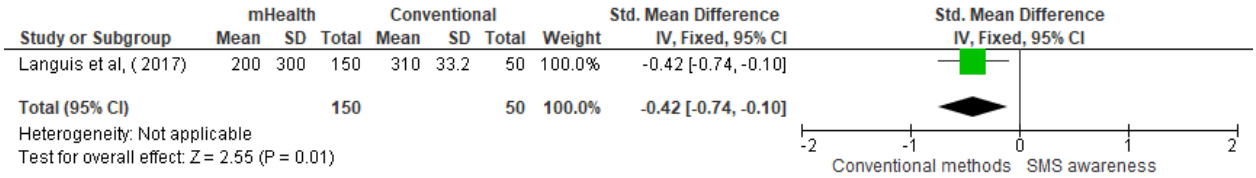

Figure 9. Analysis of non-RCT study shows the effect of text intervention

For the RCT study (Lee et al, 2018), it shows an improvement on women with breast cancer awareness that had been used as conventional methods as seen in Figure 10.

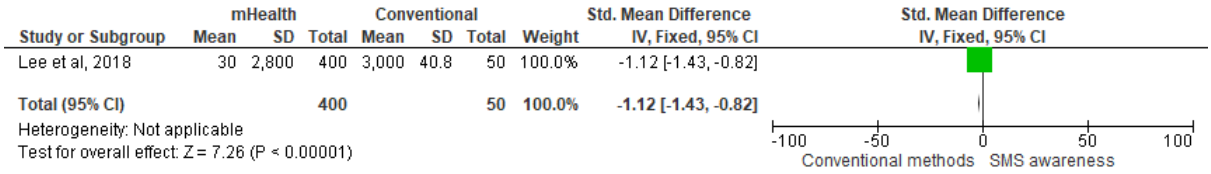

Figure 10. Analysis of one breast cancer studies shows the effect of a text message as awareness.

CHAPTER FIVE: DISCUSSION, RECOMMENDATIONS AND CONCLUSION

The purpose of this review is to determine and describe the impact of mobile health interventions on breast cancer awareness and prevention in women aged 18 and up the findings of a systematic review will aid in the development of her mHealth intervention for breast cancer. This study will also determine which of her mHealth technology modalities such as SMS are appropriate for increasing breast cancer awareness in the target population.

5.1. Discussion

The systematic review sought to ascertain the impact of mobile phones messages on sensitization. This section describes the findings in relation to the study's purpose and summarizes the study's limitations. Conclusions are reached, and recommendations for further research are made.

A total of 52 studies were found in the preliminary search. Only 15 articles remained after duplicates were removed and eligibility criteria were checked. According to the literature and the findings of this review, there are few peer-reviewed studies that use mHealth to raise breast cancer awareness. RCTs, the gold standard for study design, were also included.

There must be no gaps. Performing a systematic review of recent articles about mobile health interventions in all cancer types. This systematic literature review study focuses on recent technological trends that have not been covered in previous reviews.

Furthermore, data on digital literacy and health status are limited, both of which are necessary confounders (Hagoel et al., 2016, Hagoel et al., 2019). Future studies should investigate regular use of SMS reminders and medication and appointment adherence in cancer patients. SMS platform used by Adolescent and Young Adult (AYA) cancer survivors could not determine whether a message was read (Fortier et al., 2016, Psihogios et al., 2019).

.

Additionally, participants responded differently to text messages. The use of open-ended questions in the Breast Cancer Survivors mobile app (Life in a Day) can limit the qualitative data available from studies (Ainsworth et al., 2018). Methodological Problems There are many methodological problems in the existing literature. a) Emphasis on self-disclosure in colorectal cancer patients who self-reported neurotoxin side effects, nonverbal information was lost because short telephone interviews were used instead of lengthy interviews in person except for the possibility that only patients with positive attitudes were included in these interviews (Drott et al., 2016).

5.2. Conclusions and recommendations

We recommend conducting high- clinical excellence trials to direct future initiatives. Larger sample sizes and frame-based designs are needed to obtain more meaningful research results. A greater focus should be placed on integrating the evidence base, efficacy, cancer patients' privacy and safety related apps. Additionally, mHealth interventions must be thoroughly researched and tested for complexity before being released to the public. Furthermore, these interventions must be accepted and usable by stakeholders before the experimental research phase is conducted. There is a need to develop mHealth interventions that are theoretically sound and have a well-defined framework design. Future research would benefit from a careful description of the key components of mHealth interventions used by cancer patients. Cost-effectiveness data need to be collected before mHealth interventions can be recommended for cancer management. We also suggest that future interventions will focus on better understanding and investigating the efficacy of various components of mHealth interventions to assist cancer patients and survivors in managing their health.

Conclusion

The novelty of this review is one of its strengths, as it is the first systematic review to address the current state of the impact of mHealth interventions on disease management in patients with different types of cancer. In this study, we reviewed previous literature and identified core components of mHealth interventions that improve the quality of life and well-being of cancer patients, survivors and their caregivers. To avoid errors and bias in the review, best practises in systematic review were applied. Complex and diverse interventions with a wide range of study designs and outcomes were used. It also involved three independent reviewers at all stages of the review process. This systematic literature review will contribute to the improvement and development of future mHealth interventions for cancer care and management, the clinical, physical and psychological concerns of cancer patients and survivors.

The broad selection criteria used in this study resulted in a larger evidence base covering the use of mHealth interventions for different cancer types in the care of cancer patients and survivors. In contrast, previous systematic reviews of the literature on this topic focused on specific cancer types and limited their contributions to single cancer types. Therefore, one of the main strengths of this systematic literature review is to provide an important summary of the evidence on the use of mHealth interventions to improve quality of life and well-being across different cancer types. Although this review acknowledges that face-to-face interventions are preferable for cancer patients and survivors, our findings highlight the promising potential of mHealth interventions to support cancer patients and survivors needs further development and testing. Mobile apps and SMS were the most commonly used mHealth interventions.

Cancer screening with mHealth has the possibility of significantly reduce cancer-related morbidity and mortality demonstrate the effectiveness of using his mHealth interventions to promote appropriate care for cancer patients and survivors. A focused and collaborative effort is needed to identify cancer-specific apps that provide trusted tools for disease management for cancer patients and survivors. The results of this review highlight the promising potential of mHealth interventions to support disease management in cancer patients and survivors, which requires

further research and testing. As his mHealth interventions for cancer patients and survivors become more promising, evidence-based guidelines for their development and evaluation will be needed.

A systematic literature search had some limitations. Despite using rigorous search and analysis methods, the current systematic literature has several limitations. First, not all relevant studies were identified as the search was limited to English (non-English articles, for example). Second, there are six databases that are sufficient for a systematic review, but more sources may enable more comprehensive reviews in the future. Third, the review only considered two important psychological measures: quality of life and well-being. Other psychological features, such as fatigue and symptoms of second-line cancer treatment, need further investigation.

Fourth, the search was last updated in August of this year. Given the rapidly developing field of research, other publications may already by the time this is published. This is a common mistake in systematic reviews. There are several findings in the current systematic literature review. These limitations should be considered in future research. Only full-text articles from peer-reviewed journals will be accepted to be used for selection of relevant studies. It is always possible that many successful mHealth interventions have not been published in scientific journals. Regardless of this constraint, the search strategy used in this systematic literature review was exhaustive, strict, and in line with previous articles published in JMR.

REFERENCES

Abedi-Ardekani B, Kamangar F, Hewitt SM, Hainaut P, Sotoudeh M, & Abnet CC. 2010. Polycyclic aromatic hydrocarbon exposure in oesophageal tissue and risk of oesophageal squamous cell carcinoma in North-Eastern Iran. *digestive tract, 59*(1178):83.

Abraham, C. & Michie, S. 2008. A taxonomy of behaviour change techniques used in interventions. *Health Psychology, 27*(3): 379–387.

Ainsworth, M.C., Pekmezi, D., Bowles, H., Ehlers, D., McAuley, E., Courneya, K.S. & Rogers, L.Q. 2018. Acceptability of a mobile phone app for measuring time use in breast cancer survivors (life in a day): mixed-methods study. *Journal of Medical Internet Research cancer, 4*(1): 8951.

Alshakhs, F. & Alanzi, T. 2018. The evolving role of social media in health-care delivery: measuring the perception of health-care professionals in Eastern Saudi Arabia. *Journal of Multidisciplinary Healthcare*, *11*:473.

Ali, E.E., Leow, J.L., Chew, L. & Yap, K.Y.L. 2018. Patients' perception of app-based educational and behavioural interventions for enhancing oral anticancer medication adherence. *Journal of Cancer Education*, *33*(6):1306-1313.

Alshawwa, S.Z. & Assiri, R.A., 2020. mHealth interventions for cancer care and support a systematic literature review. *Systematic Reviews in Pharmacy*, *11*(9):725-744.

Aranda-Jan, C.B., Mohutsiwa-Dibe, N. & Loukanova, S. 2014. Systematic review on what works, what does not work and why of implementation of mobile health (mHealth) projects in Africa. *BMC Public Health, 14*(1):188-203.

Arbyn, M., Weiderpass, E., Bruni, L., de Sanjosé, S., Saraiya, M., Ferlay, J. & Bray, F., 2020. Estimates of incidence and mortality of cervical cancer in 2018: a worldwide analysis. *The Lancet Global Health*, *8*(2):191-203.

Arksey, H. & O'Malley, L. 2005. Scoping studies: towards a methodological framework. *International Journal of Social Research Methodology, 8*(1):19-32.

Asombang, A.W, Kayamba, V., Lisulo, M.M., Trinkaus, K, Mudenda, V. & Sinkala E. 2016. Esophageal squamous cell cancer in a highly endemic region. *World journal of gastroenterology, 22*(28):11.

Balzer, B.W., Kelly, P.J., Hazell, P., Paxton, K., Hawke, C. & Steinbeck, K.S. 2014. Text messaging is a useful reminder tool. *Archives of disease in childhood, 99(7):666-667.*

Barbosa, A.L., Vermeulen, S.H., Aben, K.K., Grotenhuis, A.J., Vrieling, A., Kiemeney, L.A. 2018. Smoking intensity and bladder cancer aggressiveness at diagnosis.*Public Library of Science one13:* 0194039.

Bastawrous, A., Dean, W.H. and Sherwin, J.C. 2013. Blindness & visual impairment due to age-related cataract in sub-Saharan Africa: a systematic review of recent population-based studies. *British Journal of Ophthalmology*, *97*(10):1237-1243.

Bender, J.L., Yue, R.Y.K., To, M.J., Deacken, L. & Jadad, A.R. 2013. A lot of action, but not in the right direction: Systematic review and content analysis of smartphone applications for the prevention, detection, and management of cancer. *Journal of medical Internet research, 15*(12):287.

Beratarrechea, A., Lee, A.G., Willner, J.M., Jahangir, E., Ciapponi, A. & Rubinstein, A., 2014. The impact of mobile health interventions on chronic disease outcomes in developing countries: a systematic review. *Telemedicine and e-Health*, *20*(1):75-82.

Błajda, J., Barnaś, E. & Kucab, A. 2022. Application of Personalized Education in the Mobile Medical App for Breast Self-Examination. *International journal of environmental research and public health*, *19*(8):4482.

Bloomfield, G.S., Vedanthan, R., Vasudevan, L., Kithei, A., Were, M. & Velazquez, E.J. 2014. Mobile health for non-communicable diseases in Sub-Saharan Africa: a systematic review of the literature and strategic framework for research. *Global. Health, 10*(1):1-49.

Bray, F., Ferlay, J., Soerjomataram, L., Siegel, R.L., Torre, L.A. & Jemal, A. 2018. Global cancer statistics. Globocan estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA: cancer journal for clinicians, 68*:394–424.

Buneviciene, I., Mekary, R.A., Smith, T.R., Onnela, J.P. & Bunevicius, A. 2021. Can mHealth interventions improve quality of life of cancer patients? A systematic review & meta-analysis. *Critical Reviews in Oncology/Hematology*, *157*:103123.

Cabanillas, M.E., McFadden, D.G. & Durante, C. 2016. Thyroid cancer. *The Lancet*, *388*(10061):2783-2795.

Casson, A.J. & Leder, R. 2013. The many different ways of saying mobile: the natural history of mHealth at EMBC. *Transactions of Japanese Society for Medical and Biological Engineering*, *51*(Supplement): M-24.

Chalabi, N., Bernard-Gallon, D.J., Bignon, Y.J., Agier, M., Vidal, V., Laplace-Chabaud, V., Sylvain-Vidal, V., Bertholet, V., De Longueville, F., Lacroix, M. & Leclercq, G. 2008. Comparative clinical and transcriptomal profiles of breast cancer between French and South Mediterranean patients show minor but significative biological differences. *Cancer Genomics & Proteomics*, *5*(5):253-261.

Chalya PL, Rambau PF, Masalu N, Simbila S. 2015. Ten-year surgical experiences with penile cancer at a tertiary care hospital in North-western Tanzania: a retrospective study of 236 patients. *World journal of surgical oncology*, *13:71*.

Casillas, S. & Barbadilla, A. 2017. Molecular population genetics. *Genetics, 205*(3):1003-1035.

Carter, M.C., Burley, V.J., Nykjaer, C. & Cade, J.E. 2013. Adherence to a smartphone application for weight loss compared to website and paper diary: pilot randomized controlled trial. *Journal of medical Internet research*, *15*(4): 2283.

Chan, B.A. & Hughes, B.G. 2015. Targeted therapy for non-small cell lung cancer: current standards and the promise of the future. *Trans Lung Cancer Res, 4*(1):36.

Cruz, F.O.A.M., Vilela, R.A., Ferreira, E.B., Melo, N.S. & Dos Reis, P.E.D. 2019. Evidence on the use of mobile apps during the treatment of breast cancer: systematic review. *Journal of Medical Internet Research mobile Health and Ubiquitous Healthcare*, *7*(8): 13245.

Cheung, Y.T.D., Chan, C.H.H., Lai, C.K.J., Chan, W.F.V., Wang, M.P., Li, H.C.W., Chan, S.S.C. & Lam, T.H. 2015. Using WhatsApp and Facebook online social groups for smoking relapse prevention for recent quitters: a pilot pragmatic cluster randomized controlled trial. *Journal of medical Internet research*, *17*(10): 4829.

Cronjé, L., Becker, P., Paterson, A., Ramsay, M. 2009. Hereditary non-polyposis colorectal cancer is predicted to contribute towards colorectal cancer in young South African blacks. *South African Journal of Science*, 105(1):68–72.

Cumberbatch, M.G.K., Jubber, I., Black, P.C., Esperto, F., Figueroa, J.D., Kamat, A.M., Kiemeney, L., Lotan, Y., Pang, K., Silverman, D.T. & Znaor, A. 2018. Epidemiology of bladder cancer: a systematic review and contemporary update of risk factors in 2018. *European urology, 74*(6):784-795.

Dahiya, N. & Kakkar, A.K. 2016. Mobile health: Applications in tackling the Ebola challenge. *Journal of Family Medicine and Primary Care*, *5*(1):192.

Davis, S.W. & Oakley-Girvan, I. 2017. Achieving value in mobile health applications for cancer survivors. *Journal of Cancer Survivorship, 11*(4):498–504.

DeSantis, C.E., Fedewa, S.A., Goding Sauer, A., Kramer, J.L., Smith, R.A. & Jemal, A. 2016. Breast cancer statistics, 2015: Convergence of incidence rates between black and white women. *CA: a cancer journal for clinicians*, *66*(1):31-42.

DiCarlo, J.M., Gopakumar, S., Dhillon, P.K. & Krishnan, S. 2016. Adoption of information and communication technologies for early detection of breast & cervical cancers in low- and middle-income countries. *Journal of global oncology, 2*(4):222-234.

Dhieb, D., Belguith, I., Capelli, L., Chiadini, E., Canale, M., Bravaccini, S., Yangui, I., Boudawara, O., Jlidi, R., Boudawara, T. & Calistri, D. 2019. Analysis of genetic alterations in tunisian patients with lung adenocarcinoma. *Cells*, *8*(6):514.

Drott, J., Vilhelmsson, M., Kjellgren, K. & Berterö, C. 2016. Experiences with a self-reported mobile phone-based system among patients with colorectal cancer: a qualitative study. *Journal of Medical Internet Research mobile Health and Ubiquitous Healthcare*, *4*(2): 5426.

Drukteinis, J.S., Mooney, B.P., Flowers, C.I. & Gatenby, R.A. 2013. Beyond mammography: new frontiers in breast cancer screening. *The American journal of medicine*, *126*(6):472-479.

Dudley, D.M., Newman, C.M., Lalli, J., Stewart, L.M., Koenig, M.R., Weiler, A.M., Semler, M.R., Barry, G.L., Zarbock, K.R., Mohns, M.S. & Breitbach, M.E. 2017. Infection via mosquito bite alters Zika virus tissue tropism and replication kinetics in rhesus macaques. *Nature communications*, *8*(1):1-11.

Dunsmuir, D.T., Payne, B.A., Cloete, G., Petersen, C.L., Görges, M., Lim, J., von Dadelszen, P., Dumont, G.A., & Ansermino, J.M. 2014. Development of mHealth applications for pre-eclampsia triage. *IEEE J Biomed Health Inform, 18*(6):1857–64.

Fairhurst, K. & Sheikh, A. 2008. Texting appointment reminders to repeated non-attenders in primary care: randomised controlled study. *BMJ Quality & Safety*, *17*(5):373-376.

Fairley, C.K., Levy, R., Rayner, C.R., Allardice, K., Costello, K., Thomas, C., McArthur, C., Kong, D., Mijch, A. & Melbourne Adherence Group. 2003. Randomized trial of an adherence programme for clients with HIV. *International journal of STD & AIDS*, *14*(12):805-809.

Ferlay, J., Soerjomataram, I., Dikshit, R., Eser, S., Mathers, C. & Rebelo, M. 2015 Cancer incidence and mortality worldwide: sources, methods and major patterns in globocan. *International Journal of Cancer, 136*: 359–86.

Ferrer-Roca, O., Cardenas, A., Diaz-Cardama, A. & Pulido, P. 2004. Mobile phone text messaging in the management of diabetes. *Journal of telemedicine and telecare*, *10*(5):282-285.

Free, C., Phillips, G., Felix, L., Galli, L., Patel, V. &. Edwards, P. 2010. The effectiveness of M-health technologies for improving health and health services: a systematic review protocol. *Bio Med Central Research Notes 3,* 250.

Free, C., Phillips, G., Galli, L., Watson, L., Felix, L., Edwards, P., Patel, V. & Haines, A. 2013. The effectiveness of mobile-health technology-based health behaviour change or disease management interventions for health care consumers: a systematic review. *PLoS medicine*, *10*(1): e1001362.

Fontana, E. & Smyth, E.C. 2016. Novel targets in the treatment of advanced gastric cancer: a perspective review. *Therapeutic Advances in Medical Oncology8*:113–25.

Fortuin, J., Salie, F., Abdullahi, L.H. & Douglas, T.S. 2016. The impact of mHealth interventions on health systems: a systematic review protocol. *Systematic Review, 5*(1):200-206.

Fortier, M.A., Chung, W.W., Martinez, A., Gago-Masague, S. & Sender, L. 2016. Pain buddy: A novel use of m-health in the management of children's cancer pain. *Computers in biology and medicine*, *76*:202-214.

Fu, G., Ding, Y., Seal, A., Chen, B., Sun, Y. & Bolton, E. 2016. Predicting drug target interactions using meta-path-based semantic network analysis. *BMC bioinformatics*, *17*(1):1-10.

Gelband, H. & Sloan, F.A. 2007. *Cancer control opportunities in low-and middle-income countries*. Washington DC: National Academies Press.

Ginsburg, O.M., Chowdhury M., Wu, W., Chowdhury M.T., Pal, B.C., Hasan, R., Khan, Z.H., Dutta, D., Saeem, A.A., Al-Mansur, R., Mahmud, S., Woods, J.H., Story, H. H. & Salim, R. 2014. An mHealth model to increase clinic attendance for breast symptoms in rural Bangladesh: can bridging the digital divide help close the cancer divide? *Oncologist, 19*(2):177–185.

Glynn, L.G., Hayes, P.S., Casey, M., Glynn, F., Alvarez-Iglesias, A., Newell, J., ÓLaighin, G., Heaney, D., O'Donnell, M. and Murphy, A.W. 2014. Effectiveness of a smartphone application to promote physical activity in primary care: the SMART MOVE randomised controlled trial. *British Journal of General Practice*, *64*(624): 384-391.

Gurol-Urganci, I., de Jongh, T., Vodopivec-Jamsek, V., Atun, R. & Car, J. 2013. *Mobile phone messaging reminders for attendance at healthcare appointments*. Cochrane database of systematic reviews, (12).

Gustafson, D.H., McTavish, F.M., Chih, M.Y., Atwood, A.K., Johnson, R.A., Boyle, M.G., Levy, M.S., Driscoll, H., Chisholm, S.M., Dillenburg, L. & Isham, A. 2014. A smartphone application to support recovery from alcoholism: a randomized clinical trial. *JAMA psychiatry*, *71*(5):566-572.

Hagoel, L., Neter, E., Stein, N. & Rennert, G. 2016. Harnessing the Question–Behavior Effect to Enhance Colorectal Cancer Screening in an mHealth Experiment. *American journal of public health*, *106*(11):1998-2004

Hagoel, L., Stein, N., Rennert, G. & Neter, E. 2019. Better ask than tell: Responses to mHealth interrogative reminders and associations with colorectal cancer screening subsequent uptake in a prospective cohort intervention. *Journal of Medical Internet Research mobile Health and Ubiquitous Healthcare*, *7*(1): 9351.

Higgins, J., & Green, S. 2008. *Cochrane handbook for systematic reviews of interventions*. Chichester, England: Wiley-Blackwell.

Hooi, J.K., Lai, W.Y., Ng, W.K., Suen, M.M., Underwood, F.E., Tanyingoh, D., Malfertheiner, P., Graham, D.Y., Wong, V.W., Wu, J.C. & Chan, F.K. 2017. Global prevalence of Helicobacter pylori infection: systematic review and meta-analysis. *Gastroenterology, 153*(2):420-429.

Hong, H., Kim, K., Lee, S. & Kim, H. 2009. Adoption of a PDA-Based Home Hospice Care System for Cancer Patients. *Computer Informatics Nursing, 27*(6):365-371.

Howlader, N.N.A.K.M., Noone, A.M., Krapcho, M., Garshell, J., Neyman, N., Altekruse, S.F., Kosary, C.L., Yu, M., Ruhl, J., Tatalovich, Z. & Cho, H. 2014. *SEER cancer statistics review,* 1975–2010.

Huang, A., Chen, C., Bian, K., Duan, X., Chen, M., Gao, H., Meng, C., Zheng, Q., Zhang, Y., Jiao, B. & Xie, L. 2013. WE-CARE: an intelligent mobile telecardiology system to enable mHealth applications. *IEEE Journal of Biomedical and Health Informatics, 18*(2):693-702.

Im, S.A., Lu, Y.S., Bardia, A., Harbeck, N., Colleoni, M., Franke, F., Chow, L., Sohn, J., Lee, K.S., Campos-Gomez, S. & Villanueva-Vazquez, R. 2019. Overall survival with ribociclib plus endocrine therapy in breast cancer. *New England journal of medicine*, *381*(4):307-316.

Jay, E. 2013. *Unlocking the potential in mobile phones for Cancer Care Medic Mobile.* Available at: http://medicmobile.org/2013/05/03/unlocking-the-potential-in-mobile-phones-for-cancer-care/ [28 November 2021].

Kahn, J.G., Yang, J.S. & Kahn, J.S. 2010. Mobile health needs and opportunities in developing countries. *Health affairs*, *29*(2): 252-258.

Kaplan, W.A. 2006. Can the ubiquitous power of mobile phones be used to improve health outcomes in developing countries? *Globalization and health*, *2*(1):1-14.

Kapoor, A., Nambisan, P. & Baker, E. 2020. Mobile applications for breast cancer survivorship and self-management: A systematic review. *Health informatics journal*, *26*(4): 2892-2905.

Katsidzira, L., Gangaidzo, I., Thomson, S., Rusakaniko, S., Matenga, J. & Ramesar, R. 2017. The shifting epidemiology of colorectal cancer in sub-Saharan Africa. *The Lancet Gastroenterology & Hepatology, 2*(5):377-383.

Katsidzira, L., Gangaidzo, I.T., Makunike-Mutasa, R., Manyanga, T., Matsena-Zingoni, Z., Thomson, S., Matenga, J.A., Rusakaniko, S. & Ramesar, R. 2019. A case-control study of risk factors for colorectal cancer in an African population. *European journal of cancer prevention, 28*(3):145.

Kenfield, S.A., Stampfer, M.J., Chan, J.M. and Giovannucci, E., 2011. Smoking and prostate cancer survival and recurrence. *Jama*, *305*(24):2548-2555.

Kessel, K.A., Vogel, M.M., Schmidt-Graf, F. & Combs, S.E. 2016. Mobile apps in oncology: a survey on health care professionals' attitude toward telemedicine, mHealth, and oncological apps. *Journal of medical Internet research*, *18*(11): 6399.

Khaldi, K. 2017. Quantitative, qualitative or mixed research: which research paradigm to use? *Journal of Educational and Social Research, 7*(2):15-24.

Kumar, S., Nilsen, W.J., Abernethy, A., Atienza, A., Patrick, K., Pavel, M. 2013. Mobile health technology evaluation: the mHealth evidence workshop. *American Journal of Preventive Medicine*, *45*(2):228-236.

Labrique, A.B., Vasudevan, L., Kochi, E., Fabricant, R. & Mehl, G. 2013. mHealth innovations as health system strengthening tools: 12 common applications and a visual framework. *Global health: science and practice*, *1*(2):160-171.

LaDronka, R.M., Ainsworth, S., Wilkins, M.J., Norby, B., Byrem, T.M. & Bartlett, P.C. 2018. Prevalence of bovine leukemia virus antibodies in US dairy cattle. *Veterinary Medicine International*.

Laing, B.Y., Mangione, C.M., Tseng, C.H., Leng, M., Vaisberg, E., Mahida, M., Bholat, M., Glazier, E., Morisky, D.E. & Bell, D.S. 2014. Effectiveness of a smartphone application for weight loss compared with usual care in overweight primary care patients: a randomized, controlled trial. *Annals of Internal medicine*, *161*(10_Suppl): S5-12.

Langius-Eklöf, A., Crafoord, M.T., Christiansen, M., Fjell, M. & Sundberg, K. 2017. Effects of an interactive mHealth innovation for early detection of patient-reported symptom distress with focus on participatory care: protocol for a study based on prospective, randomised, controlled trials in patients with prostate and breast cancer. *BMC cancer*, *17*(1):1-10.

Latif, S., Rana, R., Qadir, J., Ali, A., Imran, M.A. & Younis, M.S. 2017. Mobile health in the developing world: Review of literature and lessons from a case study. *IEEE Access*, (*5)*: 11540-11556.

Lee, H.Y., Koopmeiners, J.S., McHugh, J., Raveis, V.H. & Ahluwalia, J.S. 2016. mHealth pilot study: text messaging intervention to promote HPV vaccination. *American journal of health behavior*, *40*(1):67-76.

Lee, J., Grey, M.X., Ha, S., Kunz, T., Jain, S., Ye, Y., Srinivasa, S.S., Stilman, M. & Liu, C.K. 2018. Dart: Dynamic animation and robotics toolkit. *Journal of Open Source Software*, *3*(22):500.

Lee, H.Y., Lee, M.H., Gao, Z. & Sadak, K. 2018. Development and evaluation of culturally and linguistically tailored mobile app to promote breast cancer screening. *Journal of Clinical Medicine*, *7*(8):181.

Lei, J., Ploner, A., Elfström, K.M., Wang, J., Roth, A., Fang, F., Sundström, K., Dillner, J. and Sparén, P. 2020. HPV vaccination and the risk of invasive cervical cancer. *New England Journal of Medicine*, *383*(14):1340-1348.

Leon, N., Schneider, H. & Daviaud, E. 2012. Applying a framework for assessing the health system challenges to scaling up mHealth in South Africa. *Bone Marrow Concentrate Medical Information Decision Making, 12*(1), 123-135.

Leon, M.E., Assefa, M., Kassa, E., Bane, A., Gemechu, T., Tilahun, Y., Endalafer, N., Ferro, G., Straif, K., Ward, E. & Aseffa, A. 2017. Qat use and esophageal cancer in Ethiopia: A pilot case-control study. *Public Library of Science, 12*(6): e0178911.

Lichtenstein, P., Holm, NV., Verkasalo, PK., Iliadou, A., Kaprio, J., Koskenvuo, M. 2000. Environmental and heritable factors in the causation of cancer–analyses of cohorts of twins from Sweden, Denmark, and Finland. *New England Journal of Medicine343*:78–85.

Lin, H., Chen, W., Luo, L., Congdon, N., Zhang, X., Zhong, X., Liu, Z., Chen, W., Wu, C., Zheng, D. & Deng, D. 2012. Effectiveness of a short message reminder in increasing compliance with pediatric cataract treatment: a randomized trial. *Ophthalmology*, *119*(12):2463-2470.

Linde, D.S., Andersen, M.S., Mwaiselage, J.D., Manongi, R., Kjaer, S.K. & Rasch, V. 2017. Text messages to increase attendance to follow-up cervical cancer screening appointments among HPV-positive Tanzanian women (Connected2Care): study protocol for a randomised controlled trial. *Trials*, *18*(1):1-10.

Lyu, K.X., Zhao, J., Wang, B., Xiong, G.X., Yang, W.Q., Liu, Q.H., Zhu, X.L., Sun, W., Jiang, A.Y., Wen, W.P. & Lei, W.B. 2016. Smartphone application WeChat for clinical follow-up of discharged patients with head and neck tumors: a randomized controlled trial. *Chinese Medical Journal*, *129*(23):2816-2823.

Ma, F. 2015. A review of research methods in EFL education. *Theory and Practice in Language Studies, 5*(3):566-571.

Mahfoudh, W., Bouaouina, N., Ahmed, S.B., Gabbouj, S., Shan, J., Mathew, R., Uhrhammer, N., Bignon, Y.J., Troudi, W., Elgaaied, A.B.A. & Hassen, E. 2012. Hereditary breast cancer in Middle Eastern and North African (MENA) populations: identification of novel, recurrent and founder BRCA1 mutations in the Tunisian population. *Molecular Biology Reports*, *39*(2):1037-1046.

Majeed, W., Aslam, B., Javed, I., Khaliq, T., Muhammad, F., Ali, A. & Raza, A. 2014. Breast cancer: major risk factors and recent developments in treatment. *Asian Pacific Journal of Cancer Prevention*, *15*(8):3353-3358.

Mays, N., Roberts, E. & Popay, J. 2001. *Synthesising research evidence*. In Fulop, N., Allen, P., Clarke, A. & Black, N. (eds*). Methods for studying the delivery and organisation of health services.* Routledge, London.

Marcolino, M.S., Oliveira, J.A.Q., D'Agostino, M., Ribeiro, A.L., Alkmim, M.B.M. & Novillo-Ortiz, D. 2018. The impact of mHealth interventions: systematic review of systematic reviews. *Journal of Medical Internet Research mobile Health and Ubiquitous Healthcare*, *6*(1): e8873.

Medimegh, I., Troudi, W., Omrane, I., Ayari, H., Uhrhummer, N., Majoul, H., Benayed, F., Mezlini, A., Bignon, Y.J., Sibille, C. & Elgaaied, A.B. 2015. Consanguinity protecting effect against breast Cancer among Tunisian women: analysis of BRCA1 haplotypes. *Asian Pacific Journal of Cancer Prevention*, *16*(9):4051-4055.

Mchembe, M.D., Rambau, P.F., Chalya, P.L., Jaka, H., Koy, M. & Mahalu, W. 2013. Endoscopic and clinicopathological patterns of esophageal cancer in Tanzania: experiences from two tertiary health institutions. *World Journal of Surgical Oncology, 11*(1):1-7.

Min, Y.H., Lee, J.W., Shin, Y., Jo, M., Sohn, G., Lee, J., Lee, G., Jung, K.H. 2014. Daily Collection of Self-Reporting Sleep Disturbance Data via a Smartphone App in Breast Cancer Patients Receiving Chemotherapy: A Feasibility Study. *Journal of Medical Internet Research, 16*(5):135.

Middleton, D.R., Menya, D., Kigen, N., Oduor, M., Maina, S.K., Some, F., Chumba, D., Ayuo, P., Osano, O., Schüz, J. & McCormack, V. 2019. Hot beverages and oesophageal cancer risk in western Kenya: Findings from the ESCCAPE case–control study. *International Journal of Cancer, 144*(11):2669-2676.

Moodley, J., Constant, D., Botha, M.H., Van der Merwe, F.H., Edwards, A. & Momberg, M. 2019. Exploring the feasibility of using mobile phones to improve the management of clients with cervical cancer precursor lesions. *BMC women's health*, *19*(1):1-10.

Momany, M.C., Martinez-Gutierrez, J., Soto, M., Capurro, D., Ciampi, F., Thompson, B. & Puschel, K. 2017. Development of mobile technologies for the prevention of cervical cancer in Santiago, Chile study protocol: a randomized controlled trial. *BMC cancer*, *17*(1):1-5.

Mousavi, S.M., Montazeri, A., Mohagheghi, M.A., Jarrahi, A.M., Harirchi, I., Najafi, M. & Ebrahimi, M. 2007. Breast cancer in Iran: an epidemiological review. *The Breast Journal*, *13*(4):383-391.

Moyer VA. 2012. Screening for cervical cancer: Us preventive services task force recommendation statement. *Ann Internal Med*, (156):880–91.

Neuman, W.L. 2014. *Social Research Methods: Qualitative and Quantitative Approaches*. 7th ed. Harlow: Pearson Education.

Nielsen, E.L., De Rosa, R.J., Macintosh, B., Wang, J.J., Ruffio, J.B., Chiang, E., Marley, M.S., Saumon, D., Savransky, D., Ammons, S.M. & Bailey, V.P. 2019. The Gemini Planet Imager Exoplanet Survey: giant planet and brown dwarf demographics from 10 to 100 au. *The Astronomical Journal*, *158*(1):13.

Oakley-Girvan, I. 2016, February. Text messaging may improve abnormal mammogram follow-up in Latinas. In *Oncology Nursing Forum*.

Obermayer, J.L., Riley, W.T., Asif, O. & Jean-Mary, J. 2004. College smoking-cessation using cell phone text messaging. *Journal of American College Health*, *53*(2): 71-78.

Ocama, P., Kagimu, M.M., Odida, M., Wabinga, H., Opio, C.K., Colebunders, B., Van Ierssel, S. & Colebunders, R. 2008. Factors associated with carcinoma of the oesophagus at Mulago Hospital, Uganda. *African health sciences, 8*(2).

Parkin, D.M., Bray, F., Ferlay, J. & Jemal, A. 2012. Cancer in Africa. *Cancer Epidemiol Prevention Biomarkers, 23*:953–66.

Phillips, U.B. 2019. *American negro slavery: a survey of the supply, employment and control of negro labor as determined by the plantation regime*. Good Press.

Plaskon, L.A., Penson, D.F., Vaughan, T.L. & Stanford, J.L., 2003. Cigarette smoking and risk of prostate cancer in middle-aged men. *Cancer Epidemiology Biomarkers & Prevention*, *12*(7):604-609.

Porter, M.P. & Stanford, J.L., 2005. Obesity and the risk of prostate cancer. *The Prostate*, *62*(4):316-321.

Psihogios, A.M., Fellmeth, H., Schwartz, L.A. & Barakat, L.P. 2019. Family functioning and medical adherence across children and adolescents with

chronic health conditions: a meta-analysis. *Journal of Pediatric Psychology*, *44*(1):84-97.

Psihogios, A.M., Li, Y., Butler, E., Hamilton, J., Daniel, L.C., Barakat, L.P., Bonafide, C.P. & Schwartz, L.A. 2019. Text message responsivity in a 2-way short message service pilot intervention with adolescent and young adult survivors of cancer. *Journal of Medical Internet Research mobile Health and Ubiquitous Healthcare*, *7*(4): e12547.

Raghunathan, N.J., Korenstein, D., Li, Q.S., Tonorezos, E.S. & Mao, J.J. 2018. Determinants of mobile technology use and smartphone application interest in cancer patients. *Cancer Medicine*, *7*(11):5812-5819.

Saidi, T., Fortuin, J., & Douglas, T.S. 2018. Nanomedicine for drug delivery in South Africa: a protocol for systematic review. *Systematic Review, 7*(1):154-161.

Schwartz, G.G., Steg, P.G., Szarek, M., Bhatt, D.L., Bittner, V.A., Diaz, R., Edelberg, J.M., Goodman, S.G., Hanotin, C., Harrington, R.A. & Jukema, J.W. 2018. Alirocumab and cardiovascular outcomes after acute coronary syndrome. *New England Journal of Medicine*, *379*(22):2097-2107.

Salmani, H., Ahmadi, M. & Shahrokhi, N. 2020. The impact of mobile health on cancer screening: a systematic review. *Cancer Informatics*, *19*,1176935120954191.

Scholz, S. & Teetz, L. 2022. Smart health via mHealth? Potentials of mobile health apps for improving prevention and adherence of breast cancer patients. *Digital Health*, *8*, .20552076221074127.

Sewram, V., Sitas, F., O'Connell, D. & Myers, J. 2014. Diet and esophageal cancer risk in the Eastern Cape Province of South Africa. *Nutrition and Cancer, 66*(5):791-799.

Siegel, R.L., Miller, K.D., Fedewa, S.A., Ahnen, D.J., Meester, R.G., Barzi, A. & Jemal, A. 2017. Colorectal cancer statistics, 2017. *CA: A Cancer Journal for Clinicians*, *67*(3):177-193.

Sundberg, K., Wengström, Y., Blomberg, K., Hälleberg-Nyman, M., Frank, C. & Langius-Eklöf, A. 2017. Early detection and management of symptoms using an interactive smartphone application (Interaktor) during radiotherapy for prostate cancer. *Supportive Care in Cancer*, *25*(7):2195-2204.

Tacconelli, E. 2010. The Lancet Infectious Diseases. *London: Centre for Reviews and Dissemination: University of York*, 226.

Teke, Z. 2017. Call for more rural health training for medical students. News24 Correspondent.

Thackeray, R., Burton, S.H., Giraud-Carrier, C., Rollins, S. & Draper, C.R. 2013. Using Twitter for breast cancer prevention: an analysis of breast cancer awareness month. *BMC cancer*, *13*(1):1-9.

Takkouche B, Regueira-Méndez C, Montes-Martínez A. 2009. Risk of cancer among hairdressers and related workers: a meta-analysis. *International journal of epidemiology38*(6):1512–31.

The World Bank. 2013. *Low & middle income.* Available at*:* http://data.worldbank.org/income-level/LMY [28 November 2021].

Thuemmler, C., Paulin, A., Jell, T. and Lim, A.K. 2018. Information technology–next generation: the impact of 5G on the evolution of health and care services. In: *Information Technology-New Generations*. 811-817. Springer, Cham.

Tighe, J., Shand, F., Ridani, R., Mackinnon, A., De La Mata, N. & Christensen, H. 2017. Ibobbly mobile health intervention for suicide prevention in Australian Indigenous youth: a pilot randomised controlled trial. *British Medical Journal open*, *7*(1): e013518.

Tokosi, T.O., Fortuin, J., & Douglas, T.S. 2017. The impact of mHealth interventions on breast cancer awareness and screening: systematic review protocol. *Journal of Medical Internet Research Protocol*, 6(12): e246.

Uhm, K.E., Yoo, J.S., Chung, S.H., Lee, J.D., Lee, I., Kim, J.I., Lee, S.K., Nam, S.J., Park, Y.H., Lee, J.Y. & Hwang, J.H. 2017. Effects of exercise intervention in breast cancer patients: is mobile health (mHealth) with pedometer more effective than conventional program using brochure? *Breast cancer research and treatment*, *161*(3):443-452.

Varshney, U. 2014. A model for improving quality of decisions in mobile health. *Decision Support Systems*, *62*:66-77.

Wang, G., Wei, Y., Qiao, S., Lin, P. & Chen, Y. 2018. *Generalized inverses: theory and computations* (Vol. 53). Singapore: Springer.

Weaver, K.E., Ellis, S.D., Denizard-Thompson, N., Kronner, D. & Miller, D.P. 2015. Crafting appealing text messages to encourage colorectal cancer screening test completion: a qualitative study. *Journal of Medical Internet Research mHealth and uHealth*, *3*(4): e4651.

Wiebe, N., Vandermeer, B., Platt, R.W., Klassen, T.P., Moher, D. & Barrowman, N.J. 2006. A systematic review identifies a lack of standardization in methods for handling missing variance data. *Journal of Clinical Epidemiology*, *59*(4):342-353.

World Cancer Report. 2014. Geneva, Switzerland: World Health Organization, International Agency for Research on Cancer.

Zhu, J., Ebert, L., Xue, Z., Shen, Q. & Chan, S.W.C. 2017. Development of a mobile application of Breast Cancer e-Support program for women with breast cancer undergoing chemotherapy. *Technology and Health Care*, *25*(2):377-382.

ANNEXURE A: PRISMA CHECK LIST

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a literature review.	
ABSTRACT			
Abstract	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings. See the PRISMA 2020 for Abstracts checklist for the complete list.	
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge, i.e., what is already known about your topic.	14
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	14
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses with study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	33
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	15

Selection process	8	State the process for selecting studies (i.e., screening, eligibility). Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	22
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	49
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	36
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	
Study characteristics	17	Cite each included study and present its characteristics (e.g., study size, PICOS, follow-up period).	42
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	48
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	51
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	54

Appendix B: Data extraction form

- Reference (First author / Year / Journal citation)
- Location: Region Country: Classification:
- Sample size: Intervention population sample (#) Control population sample (#)
- Duration of study: In months, divide by pre- and post-
- Study design type: Randomized Controlled Clinical
- Intervention: mHealth
- Modality of mHealth
- SMS
- APP
- Telephone call
- Main outcome measures: Intervention awareness
  -Breast Cancer screening
- Results:
- Note