Jurnal Ners

Volume 18, Issue 2, June 2023, p. 200-209
http://dx.doi.org/10.20473/jn.v18i2.46216

ORIGINAL ARTICLE OPEN ACCESS

Effectiveness of m-health based self-management on self-efficacy in patients with cancer: A systematic review and meta-analysis

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Responsible Editor: Ferry Efendi

Received: 6 June 2023 ○ Revised: 26 June 2023 ○ Accepted: 26 June 2023

ABSTRACT

Introduction: M-health has been developed and tested through studies in various settings and found useful for providing knowledge and experience for nurses in cancer care settings. However, none has synthesized the effectiveness of m-health on self-management of patients with cancer. To evaluate the effect of interventions using mobile-based application on patient's self-management, outcome measures were patients' medical adherence, self-efficacy and self-management level and health literacy.

Methods: This is a systematic review and meta-analysis that is reported in accordance with the guidelines of the PRISMA statement. A systematic review was conducted in five databases. Randomized controlled trials and quasi-experimental trials evaluating self-efficacy in patients with cancer were included. Critical appraisal was performed using the Critical Appraisal Checklist from the Joanna Briggs Institute. Data were synthesized using Review Manager version 4.5.

Results: Eight studies were included. There was a significant effect on self-efficacy after interventions using mobile-based applications (SMD = 0.36, CI 95%, [0.16, 0.56], p < 0.00006). Qualitative synthesis shows that the use of m-health can improve changes in health behavior, health literacy and physical activity.

Conclusions: M-health-based self-management interventions may improve self-efficacy in cancer patients. Meanwhile, changes in health behavior in patients can be significantly improved using m-health-based self-management. M-health can be integrated into health services for the management of patients with cancer.

Keywords: cancer, m-health, self-management, systematic review

Introduction

Cancer increases every year, with the Global Cancer Observatory data stating that there are 19.2 million new cases annually (IARC, 2020). Patients with cancer experience suffering, physical, psychological and spiritual, that arises due to disease processes and treatment (Iskandar et al., 2021). Chemotherapy is one of the treatments for patients with cancer that results in the onset of significant side effects such as nausea, vomiting, and weakness (Carnio et al., 2018; Romero et al., 2018). In addition to the physical, patients may experience psychological effects including anxiety, fear, confusion, and distress (Pitman et al., 2018; Wang et al., 2020). These side effects could leads to a decrease in patients' quality of life (Guan et al., 2020).

Standard medical care is provided to minimize the side effects of the treatment. In providing services to patients with cancer, nurses play an important role in improving self-management and empowering patients so that they will be able to address the symptoms and side effects caused and this further could improve their quality of life (Sedhom, 2020). Self-management

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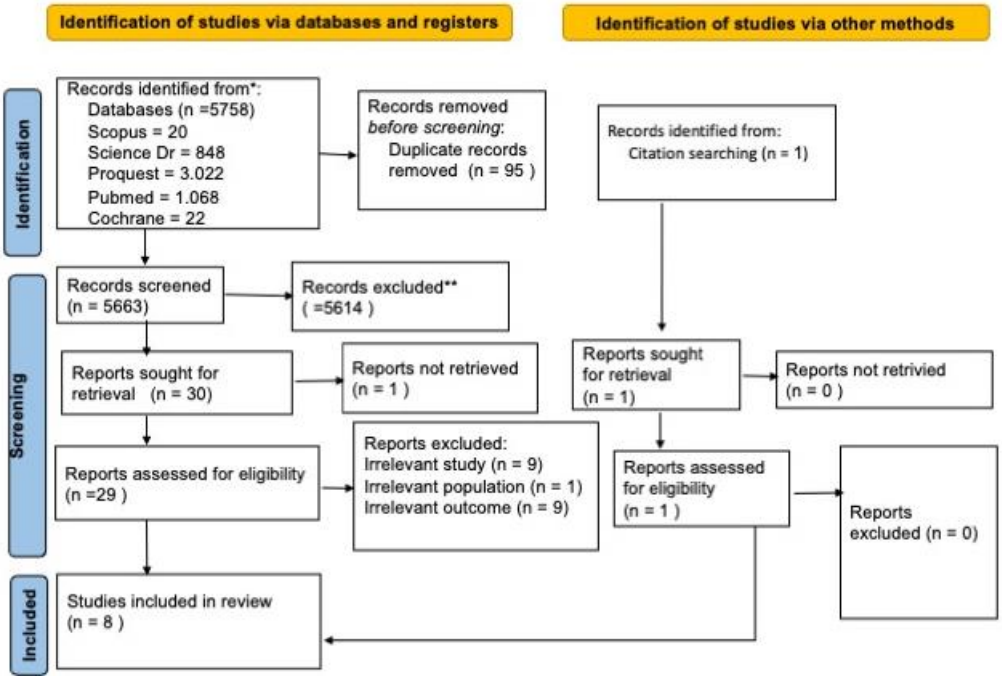

Figure 1. PRISMA Flow diagram

particularly is defined as one's intrinsic motivation and ability to live with a chronic condition and its consequences and consists of the intrinsically controlled ability of being active, responsible, informed and autonomous (Van de Velde et al., 2019). According to Bandura, self-efficacy is an important aspect in improving motivation which could lead to better self-management (Tan et al., 2021). In addition, one desired outcome of a self-management program is an improved self-efficacy (Peters et al., 2019).

Ineffective self-management will affect a patient's quality of life (Kalemikerakis et al., 2021). Previous studies demonstrate self-management interventions could improve a patient's self-efficacy, behavior and knowledge (Hanlon et al., 2017; Papadakos et al., 2018; Budhwani et al., 2019). Patients' self-management capability can be improved with various media, including the use of a mobile phone (Ni et al., 2022).

M-health is a provision of health services and information via mobile computing, mobile phones and communication technologies that aim to implement health programs for the community (Istepanian et al., 2004; Hallberg and Salimi, 2020). M-health features information, photos and videos that can effectively help patients in self-management through changing attitudes and behaviors. This leads to the improvement of the patient's quality of life. Such effects could be strengthened with the rapid development of digital technology (Armbruster et al., 2022).

Over the last five years, m-health has been developed and tested through studies in various settings (Du et al., 2020; Abasi et al., 2021; Sunjaya et al., 2022). A systematic review of m-health-based self-management among patients with cancer is useful for providing knowledge and experience for nurses in cancer care settings. Available reviews analyzed the effectiveness of m-health on the delivery of care and psychological effect (Escriva Boulley et al., 2018; Taylor et al., 2020). However, evidence on the efficacy of m-health-based self-management among patients with cancer is still lacking. Therefore, a systematic review study that aims to explore the effectiveness of m-health-based self-management on patient's behavior is needed.

Materials and Methods

Research design

This is a systematic review and meta-analysis. The review process was guided and reported by the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. The study protocol was registered to the International Prospective Register of Systematic Review (PROSPERO) with registration number CRD42022376972.

Search method and study selection

We conducted a literature search from November-December 2022 in the following databases: PubMed, Scopus, ProQuest, ScienceDirect, and Cochrane. Several keywords were used: m-health; self-management; self-

Table 1. Quality assessment for RCTs

	RCT	Baik et al., 2020	Ormel et al.,2018	Kim et al., 2018	Wang et al., 2018	Vandehout et al., 2020	Xhu et al., 2018
Q1	Was true randomization used for assignment of participants to treatment groups?	Y	Y	Y	Y	Y	Y
Q2	Was allocation to treatment groups concealed?	N	N	N	N	N	Y
Q3	Were treatment groups similar at the baseline?	Y	Y	Y	Y	Y	Y
Q4	Were participants blind to treatment assignment?	N	N	Y	Y	N	N
Q5	Were those delivering treatment blind to treatment assignment?	N	N	N	N	N	N
Q6	Were outcomes assessors blind to treatment assignment?	N	N	N	N	N	N
Q7	Were treatment groups treated identically other than the intervention of interest?	Y	Y	Y	Y	Y	Y
Q8	Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?	Y	Y	N	Y	N	Y
Q9	Were participants analyzed in the groups to which they were randomized?	Y	Y	Y	Y	N	Y
Q10	Were outcomes measured in the same way for treatment groups?	Y	Y	Y	Y	N	Y
Q11	Were outcomes measured in a reliable way?	Y	Y	Y	Y	N	Y
Q12	Was appropriate statistical analysis used?	Y	Y	Y	Y	N	Y
Q13	Was the trial design appropriate, and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?	Y	Y	Y	Y	Y	Y
Percentage		69%	69%	61%	76%	30%	62%
Category		Medium	Medium	Medium	M	M	M

efficacy and self-ability using Boolean OR and AND. Relevant studies were imported to Mendeley 1.19.4. The uploaded articles were then independently screened by two reviewers based on title and abstract using Rayyan's blind mode. Following that, the two reviewers discussed studies against study eligibility.

Inclusion and exclusion criteria

The inclusion criteria in this review are research articles that use quasi-experimental design and randomized controlled trials (RCTs), adult research participants suffering from cancer aged >18 years, and the language used is English. The target objectives in the study are m-health, self-management, self-efficacy, and self-ability. The exclusion criteria are studies that measure the use of m-health apps in non-cancer care and non-experimental studies.

Data extraction

The extracted data are created to determine the variables needed to answer the review question. The data are divided into several parts, namely study characteristics (author, year of publication, country of study), study design, number of participants during the study, type of cancer, interventions, outcome measurement and findings of the study.

Quality appraisal

Eight articles were independently assessed for their quality by two reviewers using Joanna Briggs Institute critical appraisal tools namely RCT and quasi-experiment. Discussions were made between the reviewers if there were disagreements. The total score was then categorized as moderate to high quality (Mostafaei et al., 2020). Table 1 and 2 show the quality of the included studies.

Data synthesis

To characterize the included studies, a narrative synthesis was performed. Due to the heterogeneity of the publications' parameters, it was unable to include all of them in the meta-analysis. Studies that could be further analyzed were synthesized using meta-analysis, with results reported as the mean value and standard deviation of post-intervention results.

As the studies utilized different outcome measures, the standardized mean difference (SMD) was calculated to estimate the impact of the intervention on the experimental group vs the control group. Review Manager Software (version 5.4.1) was used to perform statistical analysis. The effects of m-health-based self-management on self-management behavior were assessed. The heterogeneity of the included studies was determined statistically by examining forest plots and computing I2 tests. A value of 0% implies that no heterogeneity has been observed; increasing values indicate greater heterogeneity (Higgins et al., 2003). Studies were homogeneous, as I2 was 50%. Random

Table 2. Quality assessment for quasi-experiment

Quasi-Experiment	Q1 Is it clear in the study what is the 'cause' and what is the 'effect' (i.e. there is no confusion about which variable comes first)?	Q2 Were the participants included in any comparisons similar?	Q3 Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?	Q4 Was there a control group?	Q5 Were there multiple measurements of the outcome both pre and post the intervention/exposure?	Q6 Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?	Q7 Were the outcomes of participants included in any comparisons measured in the same way?	Q8 Were outcomes measured in a reliable way?	Q9 Was appropriate statistical analysis used?	Percentage	Category
Park et al., 2022	Y	Y	Y	Y	Y	Y	Y	Y	Y	100%	High
Sundberg et al., 2021	Y	Y	Y	Y	Y	N	Y	Y	Y	88%	High

Table 3. Data extraction

No	Author - Year	Setting	Design	Participant	Disease types	Intervention	Outcomes and outcome measurement	Outcome
1	Park et al., 2022	University Medical Centre, South Korea	Quasi-Exp	60 Enrolled and completed baseline assessment (T1). 30 Assigned to intervention group, 30 Assigned to control group	Breast Cancer	Mobile web-based self-management program	Outcome: Self-efficacy Instrument: The Self-Efficacy Scale for Self-Management of Breast Cancer (SESSM-B)	**Self-efficacy** (Self-efficacy scores did not show a significant difference by time point (F = 0.94, p = .386), nor did they show a significant difference by group (F = 0.33, p = .569)), **QOL improvement** (QOL scores differed significantly by time point (F = 4.19, p = .018) and by group (F = 7.42, p = .009))
2	Baik et al., 2020	Hospital, Italia	RCT	78 Latina breast cancer survivors analyzed; Inter 39 Control 39	Breast Cancer	Patterns of Use of Smartphone-Based Interventions	Outcome: self-efficacy and knowledge Instrument: The 12-item Communication and Attitudinal Self-Efficacy scale for cancer (CASE-cancer). The 16-item Knowledge about Breast Cancer questionnaire	The patterns of use of the My Guide intervention app and My Health attention-control app (HRQoL, symptom burden, cancer-specific distress, cancer-relevant self-efficacy, and breast cancer knowledge)
3	Ormel et al., 2018	Medical Oncology department of the UMCG, Netherland	RCT	Adult patients (n = 32). Usual care (n = 16) with RunKeeper (n = 16)	Testicular Cancer (14), Breast cancer (2)	Physical activity with a smartphone application	Outcome: physical activity Instrument: Physical Activity Scale for the Elderly (PASE) questionnaire	self-monitoring PA with RunKeeper is safe and feasible in cancer patients
4	Kim et al., 2018	Chung-Ang University Hospital, Korea	RCT	76 patients with metastatic breast cancer, mobile game play group (game group, n=36) or a conventional education group (control group, n=40)	Breast Cancer	Mobile game for self-management	Outcome: Medication adherence Instrument: The Korean version of the Medication Adherence Rating Scale (K-MARS)	The mobile game group in this study showed a higher QoL in various domains, including total health, physical health, psychological health, and environmental areas (The patients in the study group used approximately 40% of the game contents, and the overall satisfaction was acceptable. The game group also showed improved compliance to medications

Table 3. Data extraction

No	Author - Year	Setting	Design	Participant	Disease types	Intervention	Outcomes and outcome measurement	Outcome
4								compared with the control group (K-MARS score, 7.6, SD 0.7 vs 6.5, SD 0.5; P<.001). The patients in the study group reported lower rates of physically adverse events, such as nausea (P=.02), fatigue (P=.02), and numbness in the hand or foot (P=.02).Clinically significant adverse events, defined by grade ≥3 of Common Terminology Criteria for Adverse Events 3.0, including nausea (P=.02), fatigue (P=.002), and hair loss (P=.01) was shown to be lower in the game group.
5	Sundberg et al.., 2021	University hospitals in Sweden	Quasi-Exp	130 agreed to participate; 66 patients were assigned to the intervention group and 64 patients were assigned to the control group.	Prostate Cancer	Interactive app for symptom management	Outcome: Health literacy Instrument: The Swedish Functional Health Literacy Scale (FHL), and the Swedish Communicative and Critical Health Literacy Scale (CCHL)	Patients using an app for reporting and managing symptoms improved certain advanced skills of cognitive and critical health literacy (The intervention group had completed higher 188 levels of education compared to the control group (p =0.017). The 189 multinomial logistic regression showed no probability for higher 190 levels of education to result in a higher level of CCHL (model $\chi 2$ 191 =10.17, df 6, p = 0.118))
6	Wang et al, 2018	General hospitals in Nanjing, China	RCT	212 patients; intervention group (n=106) or a control group (n=106)	Stoma	Home care mobile app on the outcomes of discharged patients	Outcome: Self-efficacy Instrument: Stoma Self-Efficacy Scale (SSES)	Ostomy psychosocial adjustment = the intervention and control groups (t=0.20, P=0.06), Stoma self-efficacy = The intervention group had significantly higher SSES scores when compared with the control group, respectively at 1 month (t=2.81, P=0.01), 3 months (t=6.72, P<0.001) and 6 months (t=10.84, P<0.001) after discharge, Stoma complication = The intervention group had a lower incidence rate of stoma complications than the control group at 1-month ($\chi 2$=0.39, P=0.53)
7	Van der hout et al., 2020	Hospital, Netherland	RCT	Cancer survivors (n=625); intervention group (access to Oncokompas, n= 320) or control group (6months waiting list, n= 305)	Breast Cancer (66), Colorectal cancer (80), Head and neck Cancer (99), lymphoma (75)	eHealth self-management	Outcome: health literacy Instrument: The Patient Activation Measure (PAM)	Cancer survivors with low to moderate self-efficacy, those with higher personal control, and those with higher health literacy showed larger HRQOL benefits of Oncokompas. (Personal control also moderated the effect of Oncokompas on HRQOL (measurement group personal control, F(3,1481)=3.478, p =.015), health literacy moderated the effect of

Table 3. Data extraction

No	Author - Year	Setting	Design	Participant	Disease types	Intervention	Outcomes and outcome measurement	Outcome
								Oncokompas on HRQOL (measurement group health literacy, F(3,1478)=2.869, p = .035)
8	Zhu et al., 2018	Hunan Cancer Hospital, Xiangya School of Medicine, Central South University, Changsha, China	RCT	114 women with breast cancer; intervention group (n=57) receiving breast cancer e-support plus care as usual or the control group (n=57)	Breast Cancer	Mobile Breast Cancer e-Support Program	Outcome: Self-efficacy Instrument: The Chinese version of the Stanford Inventory of Cancer Patient Adjustment (SICPA)	The BCS program demonstrates its potential for dissemination globally to support women with breast cancer during chemotherapy

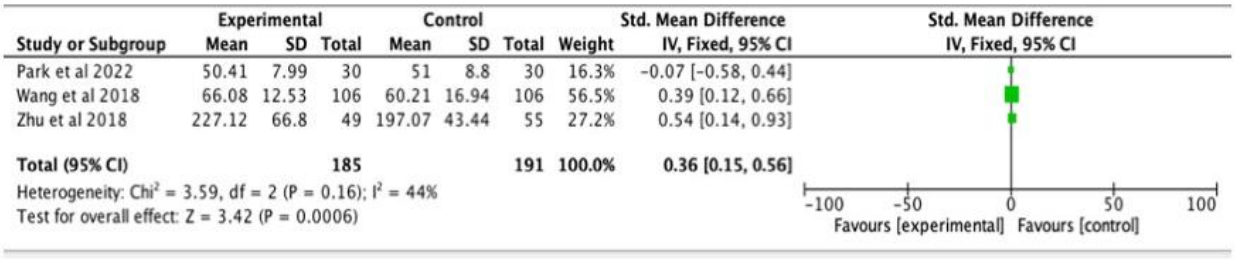

Figure 2. Meta-analysis on the effect of m-health based self-management of patient's self-efficacy

effects and fixed effects were used in the analysis. P 0.05 was chosen as the criteria for statistical significance in the systematic review.

Results

Search results

Figure 1 shows the study selection process. A total of 5758 studies were included during the literature search. After removing 95 duplicates, 5663 studies were screened through titles and abstracts. Thirty full texts were eligible for screening against inclusion criteria that resulted in eight included studies. Articles found were based on research protocols compiled to be used as a reference in conducting systematic reviews.

Study characteristics

Table 1 presents the characteristics of the eight included studies. The publication years range from 2018-2020. All the included studies were conducted in developed countries; China (n=2) Korea (n=2), Netherlands (n=2), Sweden (n=1) and Italy (n=1). The study designs used in the articles that have been analyzed are RCTs (n=6) and quasi-experiments (n=2). Table 2 and Table 3 show the quality of included studies.

Four studies focus on the application of m-health to the improvement of self-efficacy (Wang et al., 2018; Zhu et al., 2018; J.H.Park et al., 2022). Four studies investigate the application of mobile-based applications in improving, communication and health literacy (Kim et al., 2018; Ormel et al., 2018; Sundberg et al., 2021; van der Hout et al., 2021). The interventions in the included studies were conducted for four weeks (Baik et al., 2020) until six months (van der Hout et al., 2021). M-health-based self-management in the included studies provides education, hospital treatment and virtual support for physical activity and exercise.

M-health-based self-management

The features of m-health in the included studies involve; symptom management (Sundberg et al., 2021; van der Hout et al., 2021; Park et al., 2022), activity monitoring (Ormel et al., 2018), knowledge features about cancer through questionnaires (Baik et al., 2020), video games that provide education about cancer (Kim et al., 2018) and e-support (Zhu et al., 2018).

There are several outcomes of m-health based self-management interventions measured in the included studies: self-efficacy (Wang et al., 2018; Zhu et al., 2018; Baik et al., 2020; Y. Park et al., 2022); physical activity (Ormel et al., 2018), and health literacy (Baik et al., 2020; Sundberg et al., 2021; van der Hout et al., 2021).

The use of M-health for improving self-efficacy

Two RCTs (Wang et al., 2018) and one quasi-experiment study (Zhu et al., 2018; Y. Park et al., 2022) that included 376 patients with cancer evaluated the effectiveness of m-health-based self-management to improve self-efficacy. All these studies were synthesized for meta-analysis. Different measurement tools were used such as the self-efficacy scale for self-management of breast cancer, the Stoma self-efficacy scale and the Stanford Inventory cancer patient adjustment. The fixed effect model was conducted as the value of I2 is <50%. Our meta-analysis suggests there was a significant difference in self-efficacy after the provision of m-health-based self-management (SMD = 0.36 [0.16, 0.56], p < 0.00006) (Figure 2).

Use of M-health for improving health behavior, health literacy and communication

Three studies with a total of 831 participants investigated the effectiveness of m-health on the improvement of health literacy and knowledge of cancer (Baik et al., 2020; Sundberg et al., 2021; van der Hout et al., 2021). One study shows that the application of m-health can improve physical activity among patients with cancer (Ormel et al., 2018).

Discussions

This study was conducted to determine the effect of m-health-based self-management on self-management behavior including self-efficacy, health literacy and physical activity. Analysis and synthesis were carried out on three studies to see the effect of the application on self-efficacy. Our meta-analysis shows significant improvement in patients' self-efficacy after the

interventions. The finding is in line with the previous studies among patients with a life-limiting illness. For example, the use of m-health has a positive outcome on self-management (Delva et al., 2021). In addition, self-management among patients with chronic kidney disease increased in the intervention group after using m-health (Li et al., 2020; Markossian et al., 2021). Both studies provide virtual clinics, education related to diseases, and peer support. This shows that the use of the m-health app can increase self-management and self-efficacy in patients with a life-limiting illness.

Four included studies show a positive outcome in the improvement of health behavior after the intervention. The interventions provided are related to drug adherence, monitoring of patients' physical activity, and information to improve health literacy. For example, medication adherence increases in the intervention group by using mobile reminders (Kim et al., 2018). Self-monitoring can be linked to self-efficacy (Rabbani et al., 2022). Self-monitoring is carried out through an application so that it can be accessed by patients remotely. Regulated apps support changes in health efficacy and behavior and also through the m-health app can provide a better understanding of a patient's chronic condition.

Monitoring of patients' physical activity monitoring is increasing with the help of applications but further research is needed to determine the concentration of the patient's physical activity. Previous review on health apps shows that ab m-health app has the potential to increase physical activity (Yerrakalva et al., 2019). In addition, a study investigating the use of m-health on physical activity shows that the use of m-health can increase physical activity in adults through self-monitoring, social support, and behavior change techniques (McGarrigle and Todd, 2020).

Our reviews found that m-health has a positive outcome on patients' health behavior. One of the included studies shows that patients often access content with the theme of changing health behaviors (Baik et al., 2020). Improvement in health behaviors after using m-health is in line with findings of previous systematic reviews that show improvement in health behavior (Han and Lee, 2018; McKay et al., 2018). However, the use of m-health should be considered as a complementary intervention in addition to direct nursing intervention as suggested by Bonn et al. (2019).

Implication and limitations

This systematic review has a number of limitations. First, the quality of this review was compromised by the fact that no participant were blinded. Second, the included trials had varying characteristics, which could lead to heterogeneity and affect the pooled data. The included studies involved different types of cancer, and the frequency and content of the m-health interventions varied. Third, the exploration of the effect mechanism was constrained by the variety of available studies. Therefore, uniform m-health standards and high-quality randomized controlled trials and quasi-experiment are required to investigate the precise mechanism of m-health's effects.

Based on the results of a study of eight included studies, it was found that the provision of interventions for self-management in cancer patients can be done using m-health apps to improve patients' self-efficacy and health behaviors. The features provided can help patients improve self-management in undergoing cancer treatment. This intervention can be a collaborative option in implementing nursing care to help patients with cancer to meet their self-management behaviors

Conclusions

Our meta-analysis demonstrated statistically significant effects of m-health for patients with cancer patients on self-efficacy. Qualitative synthesis shows the positive outcome of m-health on patients' physical activity, health behavior and health literacy. Although, the quality of evidence range from moderate to high, the results should be considered cautiously as the standardization of m-health in term of frequency and content is still varied. Further standardization on m-health is warranted to investigate the effect of interventions.

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How to cite this article: Rochmawati, E., Anakotta, N. O., and Saidi, S. B. (2023) 'Effectiveness of m-health based self-management on self-efficacy in patients with cancer: A systematic review and meta-analysis', *Jurnal Ners*, 18(2), pp. 192-201. doi: http://dx.doi.org/10.20473/jn.v18i2.46216