Factors associated with digital interventions engagement and adherence in cancer patients: a systematic review

Lucile Montalescot, Louise Baussard, Elodie Charbonnier

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Lucile Montalescot[1]; Louise Baussard[1]; Elodie Charbonnier[1]

[1]APSY-V Université de Nîmes Nîmes FR

Corresponding Author:
Lucile Montalescot
APSY-V
Université de Nîmes
Rue du Docteur Georges Salan CS 13019, APSY-V
Nîmes
FR

Abstract

Background: eHealth interventions offer vital support for cancer patients through education, behavior change, and monitoring. Despite their potential, patient adherence to these self-help interventions is challenging. Factors like user characteristics, technology, and intervention design influence adherence. Existing reviews have gaps in exploring diverse factors associated with adherence in cancer care.

Objective: This systematic review aimed to identify factors influencing adherence to eHealth interventions with self-help components in cancer care. It examined sociodemographic, psychosocial, health-related, and intervention-related factors that affect patients' adherence to these digital health solutions.

Methods: Following PRISMA guidelines, a search was conducted across PubMed, Embase, Cochrane Library, and PsycINFO to find studies published from January 2010 to September 2021. The studies included in this review focused on adult cancer patients using eHealth interventions with self-help features. Data were extracted and synthesized using a standardized approach. Factors associated with adherence were synthesized according to their type: sociodemographic factors, psychosocial factors, health-related factors, technology-related factors, and intervention-related factors.

Results: Among 9,386 studies initially screened, 61 were eligible for analysis. These studies covered diverse eHealth intervention types, cancer types, and outcome measures. Investigating the determinants of adherence to eHealth was the main objective for 42.6% of the included studies. Adherence was gauged using varied measures such as drop-out rates, log-ins, and self-reported measures. Results regarding factors influencing adherence were inconsistent across studies. Most sociodemographic (e.g., age) and health-related factors (e.g., cancer stage) yielded mixed outcomes. However, comorbidity consistently predicted lower adherence. Results regarding psychosocial factors were more stable across studies. In particular, higher social support was associated with lower adherence. Finally, intervention-related factors like intervention type or human support showed conflicting results.

Conclusions: This review highlights the complexity of adherence to eHealth interventions in cancer care. While some factors, notably comorbidities and low social support, consistently influenced adherence, others displayed mixed associations. The review underscores the need to standardize measures, investigate specific intervention features, and enhance study quality to optimize eHealth interventions for cancer patients. Further research is crucial to better understand and improve adherence to digital health solutions in cancer care.

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Abstract

Background: Digital interventions offer vital support for cancer patients through education, behavior change, and monitoring. Despite their potential, patient adherence and engagement to these self-help interventions is challenging. Factors like user characteristics, technology, and intervention design influence adherence and engagement. Existing reviews have gaps in exploring diverse factors associated with adherence in cancer care.

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Results: Among 9,386 studies initially screened, 61 were eligible for analysis. These studies covered diverse eHealth intervention types, cancer types, and outcome measures. Investigating the determinants of adherence/engagement to digital interventions was the main objective for 42.6% of the included studies. Adherence and engagement were gauged using varied measures such as drop-out rates, log-ins, and self-reported measures. Results regarding factors associated with adherence and engagement were inconsistent across studies. Most sociodemographic (e.g., age) and health-related factors (e.g., cancer stage) yielded mixed outcomes. However, comorbidity consistently predicted lower adherence/engagement. Results regarding psychosocial factors were more stable across studies. In particular, higher social support was associated with lower adherence/engagement. Finally, intervention-related factors like intervention type or human support showed conflicting results. Adopting an intersectional perspective revealed that specificities vary according to intervention goals and the operationalization of adherence versus engagement, with women being more adherent/engaged than men in interventions targeting distress. When focusing on adherence rather than engagement, older patients were more adherent than younger patients.

Conclusions: This review highlights the complexity of adherence and engagement to digital interventions in cancer care. While some factors, notably comorbidities and low social support, were consistently linked to adherence and engagement, others displayed mixed associations. The review underscores the need for standardizing measures, investigating specific intervention features, and enhancing study quality to optimize digital interventions for cancer patients. Further research is crucial to better understand and improve adherence to digital health solutions in cancer care.

Introduction

Digital interventions include a range of technologies such as telehealth, mobile health, and web-based platforms that provide health-related information, self-help, support, and monitoring[1]. They have become increasingly popular in recent years as a means of delivering healthcare services, promoting patient self-care and improving their health[2], especially for cancer patients. Indeed, the intricate trajectory of cancer patients' treatment journey, spanning diverse healthcare settings, can be significantly enhanced through the utilization of digital interventions[3]. By acknowledging the needs encountered by cancer patients, these interventions proficiently cater to these requirements through the provision of educational materials, behavior change support, and the access to self-help resources[4–6]. Furthermore, digital interventions assume a pivotal role in fostering long-term survivorship care by facilitating the formulation of personalized treatment plans, vigilant monitoring, and advocating for healthy lifestyle choices[7]. More precisely, many digital interventions have been created and tested in the context of cancer care, to improve patients' quality of life and symptoms as well as promote healthy behaviours[7–9].

Digital health encompasses a wide range of interventions from forums to websites with various objectives (e.g., information, sharing of experience, self-assessment, behavior change). Numerous eHealth interventions rely on self-help[10,11] (i.e., interventions which can be worked through independently by patients themselves) and cancer patients hold a positive attitude both towards self-help and eHealth self-help specifically[12]. Digital interventions with a self-help component seem to be cost-effective in cancer care[13] and research has shown that they could be efficacious, sometimes just as much as in-person interventions[14]. This specific type of digital intervention seems to both address patients' needs and be efficacious to improve their quality of life and overall well-being. Yet, several studies have reported difficulties in the implementation of digital interventions, several of them related to patients' engagement and adherence[15]. Although interrelated, both concepts encompass different experiences and behaviors. Engagement has been defined by Perski[16] as both a subjective experience characterized by focused attention, interest and affect as well as the behaviors associated with this experience. In particular, these behaviors include the frequency and duration of usage. On the other hand, adherence to eHealth could be defined as the congruence between the intended use for a technology and the effective use by an individual. Moreover, the justification for the intended use should be supported by theory or rationale[17].

Adherence and engagement are often used interchangeably in studies on digital interventions. For example, some operationalize "adherence" to refer to "the more usage, the better" and without specifying an intended use. This, of course, brings up measurement issues and disparities[17,18]. Engagement is typically measured with log-ins, time spent on an intervention, or number of clicks[16]. Due to the confusion between engagement and adherence, the latter is often measured with the same indicators as engagement. However, Sieverink and colleagues note that studies that define adherence as presented previously mostly use a measure of completion of the intervention (e.g., number of modules accessed/completed)[17]. Indeed, previous work has shown that patients were less likely to be adherent to self-help interventions in comparison to interventions involving real-time interactions[19]. Engagement is an important predictor of the effectiveness of these interventions[14,20–22]. Indeed, the more patients use eHealth, the more it is effective. Although digital interventions have the potential to improve patient outcomes and increase access to healthcare services, adherence and engagement to these interventions remains a challenge[23]. This is all the more important that patients' view of the intervention appear essential to the success of an intervention's implementation[15]. Understanding the factors that influence adherence and engagement to digital interventions is critical for developing effective interventions.

Few reviews have examined the factors associated with adherence and engagement to digital

interventions. They showed that engagement depended on users' characteristics, technological aspects, and intervention features[24]. Furthermore, they highlighted that components such as personalized content, push notifications, and quizzes were associated with increased adherence and engagement[25,26]. However, the focus of these systematic reviews limits their reach. Indeed, the three systematic reviews that specifically explored adherence or engagement to digital interventions focused on the intervention features that increase said adherence/engagement and/or were conducted in very heterogeneous populations (e.g., gynecology patients, caregivers of disabled children etc.) [24–26], without addressing the specificities of cancer care. Another difficulty lies in the difficulty to define adherence in the context of digital health. In most definitions, use, engagement and adherence are considered as synonyms[17,27]. While some studies investigate digital health engagement exclusively through log-data (number of logins, number of clicks, time spent on a module etc.), other authors argue that adherence should be conceptualized as the degree to which users followed the program as it was designed[27]. In summary, the diversity in the definitions of adherence/engagement makes it challenging to investigate the topic.

In sum, to date, adherence and engagement to digital health, and particularly to self-help interventions, remains difficult to define, and the factors involved in engagement and adherence have been little investigated, specifically for cancer. Indeed, most systematic reviews published to date on digital health interventions focus on their efficacy[9,28,29] or users' experience with such interventions[30,31] with a small portion of them mentioning engagement as a secondary objective[19,32]. In this systematic review, we aim to identify and synthesize the existing literature on the factors associated with adherence or engagement to digital interventions presenting a self-help component in cancer care. Specifically, we examine the sociodemographic, psychosocial, health-related, and intervention-related factors that influence digital health adherence. We also investigate specificities according to intervention goal, operationalization of adherence/engagement, and intervention type.

Methods

The review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The present systematic review has been registered in the PROSPERO database with the following identifier: CRD42021281028.

Search strategy

A comprehensive search strategy was developed by EC and LM to identify relevant studies. The following databases were searched: PubMed, Embase, Cochrane Library, and PsycINFO. The search terms included cancer, eHealth interventions, adherence, and related synonyms. The search strategy is available in Box 1. The last systematic review with a similar objective was published in 2011[24]. For this reason, the search was limited to studies published in English from January 2010 to September 2021.

Study selection and data extraction

Two reviewers (EC and LM) independently screened titles and abstracts to identify potentially eligible studies through Rayyan software. Once the blind was off, disagreement was resolved through consensus. Full-text articles were retrieved for studies that met the inclusion criteria. Studies were included if they: (1) investigated factors associated with adherence or engagement to digital interventions; (2) said interventions should include a self-help component (i.e., components that can be worked through independently by patients themselves and imply an active participation from them); (3) included adult cancer patients. Studies were excluded if they: (1) were not original research (e.g., reviews, editorials, commentaries); (2) did not report empirical data; (3) were

qualitative studies; (4) were not an intervention trial; (5) only included information modules; (6) included symptom reporting only, without an active component; (7) included a communication module with healthcare providers, without an active component.
Three reviewers extracted data from eligible studies using a standardized data extraction form. The following data were extracted: authors, year, country, title, study design, population, intervention type, aim of the intervention, operationalization of adherence/engagement, adherence or engagement measure, intervention duration, study length, primary outcome of interest, analysis, and factors associated with adherence (See Table S1).

Data synthesis

A narrative synthesis was conducted due to the heterogeneity of the included studies in terms of study design, intervention type, and outcome measures. Factors associated with adherence and engagement were synthesized according to their type: sociodemographic factors, psychosocial factors, health-related factors, technology-related factors, and intervention-related factors. We also performed subgroup synthesis according to intervention goal, operationalization of adherence/engagement and intervention type.
The quality of the included studies could not be assessed with a standardized evaluation grid due to the variety of the designs and objectives. However, we proceeded to a narrative critical appraisal of the methods used across studies. We also quantified the studies for which we identified missing summary statistics.

Results

The search identified 9,386 potentially eligible studies, of which 61 were included in the final review. A detailed flowchart is available (See Figure 1). The interventions included web-based intervention (65.6%), mobile based intervention (26.2%), and other types of digital health interventions and/or a combination of different types of technologies (6.6%). The goals of the interventions varied (e.g., decreasing distress, behavior change etc.). Regarding the population, breast cancer was the most common cancer type across studies (67.2%). Furthermore, a large portion of studies targeted specifically cancer survivors (41.0%). Adherence and engagement were assessed with several measures in 57.3% of the included studies. The measures used included: drop-out rates (32.8%), time spent on the intervention (32.8%), number of log-ins (29.5%), number of patients' actions within the intervention (e.g., message sent, clicks) (24.6%), number of pages or modules viewed (19.7%), completion of the intervention or its modules (16.4%), self-reported measures of use (11.5%), number of active days/weeks (9.8%), specific measures linked to the use of wearables (4.9%), intention to use the app (3.3%). About 9.8% of the included studies used adherence measures specific to their intervention (e.g., doing several specific actions such as creating a user profile and posting more than two messages to a group). Even within these categories, discrepancies in measures are of note (e.g., binarization of log-ins measures, completion of the intervention as a whole vs. its modules, number of pages viewed vs. view of a specific page). Finally, investigating the determinants of adherence to eHealth was the main objective for 42.6% of the included studies. Factors associated with adherence/engagement included sociodemographic factors, psychosocial factors, health-related factors, and intervention-related factors. Unsurprisingly adherence was highly associated with other measures of engagement[33–37]. Table 1 summarizes the characteristics of the included studies while table S1 presents each study individually and in more details.

Sociodemographic factors associated with cancer patients' adherence and engagement to digital interventions

Thirty-eight studies investigated the links between sociodemographic factors and

engagement/adherence to digital interventions with many inconsistent results between studies. First, concerning age (n = 14 studies), 7 studies showed that older patients tended to be more adherent/engaged than younger ones[34,38–42], 4 that younger patients were more adherent/engaged[43–46], while 4 studies showed no significant associations between age and adherence or engagement[33,47,48]. Finally, one of these studies showed a differential association between age and engagement to digital health interventions: participants' age was not significantly related to smartwatch wearing compliance but was significantly and positively correlated with higher symptom rating compliance[49].

Second, concerning education level (n = 13 studies), 5 studies reported that higher education was associated with higher engagement or adherence[38,41,43,50,51], 3 reported the contrary[34,44,52] and 5 yielded non-significant results[33,39,40,47,53]. A study reported that patients with some college showed the highest decline in engagement compared to high school graduates and college graduates without reporting any statistical tests[39]. Reliable trends regarding economic factors were difficult to determine due to inconsistent results. Among the 5 studies that investigated these links, two showed how being from a privileged background was associated with better adherence/engagement[41,54] while 3 showed non-significant results[33,35,47]. One study highlighted how income and employment status were associated with a differential usage of specific modules[41].

Third, concerning employment (n = 9 studies), 4 studies showed that employed patients were also found to be more adherent/engaged than those who did not work[39,43,50,55], 2 reported they were less likely to be adherent/engaged[56,57] and 3 reported non-significant results[33,39,53].

Fourth, concerning gender (n = 7 studies), 3 studies showed that women were more adherent or engaged than men[43,50,58], 1 showed the contrary[34] while 3 showed no significant association[47–49]. One study showed that women were more likely to use the printed materials of an hybrid intervention than men[48].

Fifth, 5 studies examined the association between marital status and adherence. Two studies suggested that married patients may be more adherent/engaged[38,43], 2 studies yieldied non-significant results[39,47] and another showing that married patients were less adherent/engaged[59]. A study showed that higher number of people in the household was associated with lower engagement. This same article highlighted that widowed and divorced patients and participants in single households showed greater decline in engagement, but no statistical test was reported[39].

Sixth, studies on race were limited (n = 3 studies). Two studies yielded non-significant associations[33,35] and the only one that reported a significant association showed that Caucasian women were more likely to use a discussion group module[44].

Finally, patients experienced with technology (n = 3 studies) were found to be more adherent/engaged. Although technology experience was found to be associated with higher usage in 2 studies[33,43], it was not associated with higher use of specific modules[60]. Beyond experience, access to technology was associated with better digital health engagement in one study[35].

Health-related factors associated with cancer patients' adherence and engagement to digital interventions

Thirty studies reported the links between health-related factors and adherence to digital interventions, with again many inconsistent results between studies. First, concerning cancer stage (n = 7 studies), 3 studies showed that patients living with a more advanced cancer stage were more adherent/engaged[44,61,62], while 3 did not show any significant associations[33,41,48]. The last one showed that patients living with cancer stage II had the lowest engagement rate. This same study argued that patients who had breast cancer stage III showed greater decline in engagement, without

reporting statistical test[39].
Second, regarding comorbidity (n = 4 studies), patients with comorbidities were found to be less adherent/engaged in 2 studies[38,60] and one reported non-significant associations[41]. In the last study, the significance of this association depended on the time of the intervention and the comorbidity measure used[39].
Third, concerning symptoms (n = 5 studies), 2 studies showed that patients with more symptoms tended to be more adherent/engaged[34,63] while 3 reported no significant associations[39,64,65].
Fourth, concerning weight or other related measures (n = 3 studies), 1 study showed that patients with higher percentage of body fat were less adherent/engaged[66] and 2 reported no significant association[39,41]. One study highlighted higher decline in engagement in participants with high BMI without reporting statistical tests[39].
Fifth, among the 3 studies that investigated the links between diagnosis date and adherence or engagement, 1 showed that patients with an older date of diagnosis date had higher engagement[47] and the other two reporting no significant results[39,67]. The moment patients are proposed to use the intervention also seems to play a role in their adherence and engagement[35,44,45,52,62]. Only 2 studies showed no significant associations[33,67], however, authors used very different indicators (e.g., summertime, time since diagnosis, pre- or post-surgery status), which makes it difficult to identify trends.
Sixth, 2 studies examined the association between cancer type, one study showed that breast cancer patients had higher engagement[62] while the other study showed no significant differences in adherence according to cancer type[48]. Finally, a study, although not directly having cancer type as a predictor, demonstrated that the predictors of engagement between breast cancer and prostate cancer patients differed[38].
Seventh, some studies showed that treatments and medical services could be associated with adherence or engagement[41,42,50,53], but the type of treatments investigated varied greatly (e.g., surgery, sleeping medication) and the operationalization of these variables differed across studies (e.g., medical service, cycles of chemotherapy). One study did not show any difference in engagement between patients who underwent chemotherapy and those who did not[39].
Finally, a study showed that cancer patients had higher engagement scores than participants who did not live with cancer[68]. Yet, in this study, no significant differences emerged in other adherence markers, such as homework completion.

Psychosocial factors associated with cancer patients' adherence and engagement to digital interventions

Despite fewer studies examining psychosocial factors (n = 14), they have yielded more consistent results. First, concerning distress (n = 13 studies), 7 studies showed that distressed patients were more adherent or engaged more[33,44,57,58,69,70], 4 showed the contrary[35,47,50,71], and 3 did not report any significant results[36,39,72]. All the studies that showed a positive association used a measure of cancer-related distress[33,44,57,58,69–71]. In comparison, among those that showed the contrary only one used a cancer-specific measure[47]. Moreover, one of these study showed how distress was associated with engagement with different modules depending on patients' gender[71]. A study showed a differential association depending on the operationalization of engagement (e.g., binarization of use vs. use of specific modules)[71]. Finally, a study showed that although distress was a predictor of continuous app use, when controlling for gender, this association was no longer significant[58].
Second, 7 studies investigated the links between quality of life and adherence or engagement. Three studies showed that patients with better quality of life were more adherent or engaged more[65,71,73], 1 reported the contrary[44] and 3 did not report significant results[39,56,60].

Third, concerning social support (n = 6 studies), 4 studies showed that greater social support was associated with decreased adherence or engagement[44,60,69,70] and 1 showed the contrary[34]. Moreover, one of these studies showed a differential association between social constraints and engagement to digital interventions: participants' social constraints were positively associated to duration of use but negatively to unique module views[33]. As with distress, a study has highlighted a different pattern of association between social support and adherence depending on the gender of the participants[60].

Fourth, although self-efficacy was less frequently studied (n = 3 studies), it was found to be positively associated with adherence/engagement in 2 studies[47,65], while the remaining one reported non-significant results[60].

Fifth, positive perceptions of digital interventions (e.g., perceived ease of use, perceived usefulness) were consistently associated with better adherence and higher engagement in the 5 studies that investigated this factor[37,46,59,74,75]. However, one of these studies showed a differential association between intervention perception and adherence: perceived usefulness was positively associated to the intention to use the intervention, but perceived ease of use was not[74].

Sixth, the 3 studies that investigated the links between information competence and adherence/engagement reported non-significant results[33,44,76]. However, one of these three studies showed a differential association between information competence and engagement to specific modules: the more patients had high information competence the less they used the Ask the expert and Interactive services but not the information services[44].

Seventh, three studies investigated the links between resistance (such as lack of motivation or difficulty with change) and adherence or engagement. One study showed a positive association[58], another a negative one[35] and the last no significant results[77]. In one study, although resistance to change was a predictor of continuous app use, when controlling for gender this association was no longer significant[58].

Finally, other psychosocial factors have been found to be associated with adherence or engagement in single studies, such as decisional conflict[76], health perceptions[35], coping (helplessness and anxious preoccupation)[72], personality (openness)[58], previous experience with a similar intervention (mindfulness)[50], fatigue[55], unmet sexuality and physical needs[57]. Other studies investigated different factors without highlighting significant results like therapeutic alliance[78]. Another study stated that patients reporting fatigue showed greater decline in adherence without reporting statistical tests[39].

Intervention-related factors associated with cancer patients' adherence and engagement to eHealth interventions

Twenty-six studies investigated the links between intervention-related factors and adherence to digital interventions.

First, concerning intervention type (n = 11 studies), most studies have compared adherence or engagement to digital intervention with other interventions which makes it difficult to summarize these results. Four studies compared digital interventions with paper pamphlets. Three of them showed that participants were more adherent/engaged to the digital version of the intervention[45,79,80], and the last one showed no significant differences between the two types of intervention[54]. Two studies compared digital interventions with usual care. One showed that participants in the digital group engaged more in survivorship care plans than people who did not use the digital intervention[37]. The second study showed no significant differences in drop-out rates between the digital group and the usual care group[69]. Two studies compared interactive digital interventions with information-only portals. One yielded inconsistent results depending on the measure used[81] and the other non-significant results[82]. Two studies compared eHealth

interventions with face-to-face ones. One showed that participants who participated in the eHealth intervention were less adherent than those who participated in its face-to-face version[78]. The other one did not show any significant differences[34]. Two studies compared phone interventions with digital ones showing no significant differences[54,66]. Finally, 4 studies compared two different interactive digital interventions. Three did not show any significant differences[39,83,84] while the other highlighted inconsistent results depending on the chosen measure of engagement[51]. Interestingly, the possibility of interactions between patients yielded non-significant associations in the two studies that investigated this topic[74,85].

Second, the links between human support (i.e., help from a human with the use of the intervention) and adherence have been studied in only two studies, and the results were conflicting. One showed that human support was associated with increased adherence[86], the other showed the contrary[64]. However, it is worth mentioning that one of these studies showed a differential association between human support and engagement/adherence: participants in the technician-guided group logged-in more frequently than the self-help group but no significant differences were observed in the proportion of participants who completed lesson 5 between both groups[86].

Third, 2 studies investigated the effect of time on engagement. One study showed that log-in attrition was significant across the three months of the study[33] while the second showed no significant effect of time on engagement[87].

Finally, although the majority of studies included in this review did not examine the differential use of modules (only one study reported no significant differences in module usage[88]), a subset of studies investigated the impact of specific features on adherence/engagement. Findings from these studies suggest that a tunneled intervention, in which modules are presented in a fixed sequence, may lead to higher engagement than a free-choice intervention[51]. Additionally, reminders were found to be effective in improving adherence/engagement[89,90], regardless of the type of reminder used[91]. Finally, patients were found to consult modules more frequently when informed through tailored interventions that they had specific needs related to those modules[59].

Intersectional approach to adherence and engagement to digital health interventions

Given the high heterogeneity of studies and interventions as well as the contrasting results presented above, we examined these data with an intersectional approach. Indeed, we chose to investigate these factors by type of intervention, in particular the types of goals the included studies focused on (e.g., physical activity, psychological distress), operationalization of the outcome (i.e., engagement, adherence with or without justification for dose), and type of intervention (i.e., web-based vs. mobile-based). We reported on factors investigated by at least 2 studies in each subcategory.

Intervention aims

Quality of life and symptom management

Thirteen interventions centered quality of life and/or symptom management, including 3 that focused on other aims as well (e.g., distress). For interventions that targeted quality of life, 2 studies examined the association between marital status and adherence/engagement, leading to inconsistent results. One suggested that married patients had a higher engagement[38], and another showing the contrary[59]. Regarding comorbidities, patients with comorbidities had lower engagement in the 2 studies that investigated this factor [38,60].

Among the three studies that investigated the links between quality of life and adherence/engagement, results were inconsistent. One showed that better quality of life was associated with higher adherence[73], another reported the contrary[44] and the last one did not

report significant results[60]. The two studies that looked into social support showed that greater social support was associated with decreased adherence or engagement[44,60].
Regarding intervention-related factors, reminders were found to be effective in improving engagement[89,90]. This was the only factor investigated by more than two studies.

Psychological distress

Twenty-one interventions centered psychological distress, including 6 that focused on other aims as well (e.g., decisional conflict, self-efficacy). Regarding sociodemographic factors, one study reported that higher education was associated with higher engagement[43], while the two others yielded non-significant results[33,47]. The two studies that investigated economic background showed non-significant results[33,47]. Concerning employment, a reliable trend could not be identified as one study found that employed patients were also found to be more adherent than those who did not work[43], another reported they were less likely to be adherent[57] and the last one reported non-significant results[33]. Regarding gender, 2 studies showed that women were more adherent/engaged than men[43,58], and 1 showed no significant association[47]. No reliable trend could be identified regarding marital status as one study suggested that married patients may be more adherent[43], another yielded non-significant results[47] and the last one showed that married patients were less adherent[59]. Finally, technology experience was found to be associated with higher usage in 2 studies[33,43].
Regarding health-related factors, 2 studies showed that patients living with a more advanced cancer stage were more adherent[61], while 1 did not show any significant associations[33]. No reliable trend could be identified regarding the moment patients are proposed to use the intervention. Indeed, one showed significant results[62] while the other showed no significant associations[33].
Concerning distress, 5 studies showed that distressed patients had higher levels of adherence or engagement[33,57,58,69,70], 2 showed the contrary[47,71], and 2 did not report any significant results[36,72]. Regarding social support, 2 studies showed that greater social support was associated with decreased engagement[69,70].
Relative to intervention-related factors, the two studies that compared digital interventions with paper pamphlets showed that participants were more adherent to the digital version of the intervention[79,80]. Two studies compared interactive digital interventions with information-only portals. One yielded inconsistent results depending on the measure used[81] and the other non-significant results[82].

Physical activity and nutrition

Twelve interventions centered physical activity and/or nutrition, including 2 that also focused on other aims as well (e.g., smoking). First, concerning age one study showed that older patients tended engaged with the intervention more than younger ones[39], 2 showed the contrary[45,46], while one study showed no significant associations between age and adherence[48]. No reliable trend could be identified for education: one study reported that higher education was associated with higher engagement[51], one reported the contrary[52] and the last one yielded non-significant results[39]. Regarding gender, the 3 studies that investigated the topic showed no significant association[48,49].
Regarding health-related factors, one study out of two did not show any significant associations between cancer stage and engagement[48]. The other one showed that patients living with cancer stage II had the lowest engagement rate [39]. Concerning symptoms, one study showed that patients with more symptoms tended to have higher engagement while the other one reported no significant associations[39]. Regarding weight or other related measures, one study showed that patients with a higher percentage of body fat had lower engagement[66] and the other one reported no significant association[39]. Finally, the moment patients are proposed to use the intervention also seems to play

a role in their engagement among the three studies that investigated this topic[35,45,52].
Regarding psychological factors, no reliable trend regarding distress could be established as it was investigated only by two studies with contradicting results. One showed that more distressed patients had lower engagement[35], and the other one did not report any significant results[39]. However, positive perceptions of digital interventions were associated with better adherence in the 2 studies that investigated this factor within this subcategory[46,59].

Operationalization of adherence/engagement

Two studies used measures of intention to continue using the intervention as outcome. The others were classified according to Sieverink and their colleagues' classification: engagement, adherence with and without justification for intended use[17]. However, only two studies justified the intended use specified in the article. No similarity could be reported as their methods and results differed greatly. Therefore, we only report the results for studies that investigated engagement vs. the ones that investigated adherence without justification for intended use.

Engagement

Thirty-two articles used measures of engagement according to the classification proposed by Sieverink[17]. First, concerning age, 4 studies showed that older patients tended to engage more than younger ones[38–41], 3 that younger patients engaged more[44–46], while 3 studies showed no significant associations between age and engagement[33,47,48]. Second, concerning education level, 3 studies reported that higher education was associated with higher engagement[38,41,51], 2 reported the contrary[44,52] and 4 yielded non-significant results[33,39,40,47]. Among the 4 studies that investigated economic factors, one showed how being from a privileged background was associated with better engagement[41] while the other 3 showed non-significant results[33,35,47]. Concerning employment, no reliable trend could be identified as the three studies that investigated the topic reached different conclusions: one showed that employed patients were found to have higher engagement than those who did not work[39], one reported they were less likely to engage in the intervention[56] and the last one reported non-significant results[33]. Concerning gender (n = 7 studies), the 3 studies that investigated the topic showed no significant association[47,48]. Regarding marital status, one study suggested that married patients may have higher engagement[38], 2 studies yielding non-significant results[39,47]. For race, two studies yielded non-significant associations[33,35] and the only one that reported a significant association showed that Caucasian women were more likely to use a discussion group module[44]. Finally, technology experience was found to be associated with higher usage in one study[33], but was not associated with higher use of specific modules in another[60].
Regarding health-related factors, 3 studies showed that patients living with a more advanced cancer stage had higher engagement[44,61,62], while 3 did not show any significant associations[33,41,48]. Patients with comorbidities were found to be less engaged in 2 studies[38,60], one reported non-significant associations[41], and in the last study, the significance of this association depended on the time of the intervention and the comorbidity measure used[39]. Concerning symptoms, 3 reported no significant associations[39,65]. One study showed that patients with higher percentage of body fat had lower engagement[66] while 2 reported no significant association[39,41]. No reliable trend could be identified regarding diagnosis date as one study showed that patients with an older date of diagnosis date had higher engagement[47] and the other one reported no significant results[39]. The moment patients are proposed to use the intervention also seems to play a role in their engagement[35,44,45,52,62]. Only one study showed no significant associations[33]. Regarding cancer type, one study showed that breast cancer patients had higher engagement[62] while the other one showed no significant differences in engagement according to cancer type[48]. The association

between engagement and treatments/medical services yielded inconsistent results. One study showed significant differences[41], while another did not show any difference in engagement between patients who underwent chemotherapy and those who did not[39].

Regarding psychological factors, 4 studies showed that distressed patients had higher engagement[33,44,69,70], 4 showed the contrary[35,47,50,71], and 2 did not report any significant results[39,72]. Two studies showed that patients with better quality of life had higher engagement[65,71], 1 reported the contrary[44] and 3 did not report significant results[39,56,60]. Concerning social support, 4 studies showed that greater social support was associated with decreased engagement[44,60,69,70]. Self-efficacy was found to be positively associated with engagement in 2 studies[47,65], while the remaining one reported non-significant results[60]. Positive perceptions of digital interventions were associated with better engagement in the 2 studies that investigated this factor in this subcategory[37,46]. Finally, the 3 studies that investigated the links between information competence and engagement reported non-significant results[33,44,76].

Relative to intervention-related factors, two studies showed that participants had better engagement to a digital version of the intervention compared to paper pamphlets[45,79]. Two studies compared digital interventions with usual care. One showed that participants in the digital intervention group were more engaged to survivorship care plans than people who did not use the intervention[37]. The second study showed no significant differences in drop-out rates between the digital group and the usual care group[69]. Two studies compared interactive digital interventions with information-only portals. One yielded inconsistent results depending on the measure of engagement used[81] and the other non-significant results[82]. Finally, 4 studies compared two different interactive digital interventions. Three did not show any significant differences[39,83,84] while the other highlighted inconsistent results depending on the chosen measure of engagement[51]. Two studies investigated the effect of time on engagement. One study showed that log-in attrition was significant across the three months of the study[33] while the second showed no significant effect of time on engagement[87]. Additionally, reminders were found to be effective in improving engagement[89,90].

Adherence without justification for intended use

Twenty-five articles used measures of adherence without a justification for intended use, according to the classification proposed by Sieverink[17].

Regarding sociodemographic factors, 2 studies showed that older patients tended to be more adherent than younger ones[34,42]. Two studies showed that employed patients were more adherent than those who did not work[43,55], 1 reported they were less likely to be adherent[57] and 1 reported non-significant results[53]. Regarding gender, 2 studies showed that women were more adherent than men[43,58], 1 showed that men were more adherent[34] while 1 showed no significant association[49].

Regarding health-related factors, 2 studies showed that patients with more symptoms tended to be more adherent[34,63] while 1 reported no significant associations[64]. Two studies showed that treatments and medical services could be associated with adherence[42,53].

Regarding psychological factors, 2 studies showed that distressed patients were more adherent[58,69], 1 showed the contrary[71], and 1 did not report any significant results[36]. Two studies showed that patients with better quality of life were more adherent[71,73]. Concerning social support, 1 study showed that greater social support was associated with decreased adherence[69] and 1 showed the contrary[34]. One study showed a positive association between resistance and adherence[58], and the second one no significant results[77].

Concerning intervention type, 1 study showed that participants were more adherent to a digital version of the intervention compared to a paper pamphlet[80], while the other one showed no

significant differences between the two types of intervention[54]. Two studies compared eHealth interventions with face-to-face ones. One showed that participants who participated in the eHealth intervention were less adherent than those who participated in its face-to-face version[78]. The other one did not show any significant differences[34]. Second, the results regarding the links between human support and adherence were conflicting. One study showed that human support was associated with increased adherence[86], the other showed the contrary[64].

Type of intervention

We chose to investigate factors associated with adherence and engagement according to the type of intervention (web-based or mobile-based). Two interventions could not be classified in either categories.

Web-based

Forty-one articles reported on web-based interventions, including two that also included other components (i.e., CD-ROM, wearables). Regarding sociodemographic variables, 4 studies showed that older patients tended to be more adherent/engaged than younger ones[34,39,40,42], 3 showed the contrary[44–46], while 3 studies showed no significant associations [33,47,48]. Concerning education level, 3 studies reported that higher education was associated with higher engagement[43,50,51], 2 reported the contrary[34,44] and 5 yielded non-significant results[33,39,40,47,53]. The studies that investigated economic factors showed non-significant results[33,47]. Concerning employment, 4 studies showed that employed patients were also found to be more adherent or had higher engagement than those who did not work[39,43,50,55], 1 reported the contrary[57] and 3 reported non-significant results[33,39,53]. Two studies showed that women had higher engagement than men[43,50], 1 showed the contrary[34] while 2 showed no significant association[47,48]. One study suggested that married patients may be more adherent[43], 2 studies yielded non-significant results[39,47] and another showed the contrary[59]. Regarding race, one study yielded non-significant associations[33] and the only one that reported a significant association showed that Caucasian women were more likely to use a discussion group module[44]. Although technology experience was found to be associated with higher usage in 2 studies[33,43], it was not associated with higher use of specific modules in another[60].

Relative to health-related factors, 3 studies showed that patients living with a more advanced cancer stage were more adherent[44,61,62], while 2 did not show any significant associations[33,48]. The last one showed that patients living with cancer stage II had the lowest adherence rate [39]. Patients with comorbidities were found to be less adherent in one study[60] and in another the significance of this association depended on the time of the intervention and the comorbidity measure used[39]. Concerning symptoms, 2 studies showed that patients with more symptoms tended to be more adherent or to engage more in the intervention[34,63] while 2 reported no significant associations[39,64]. Concerning weight or other related measures, 1 study showed that patients with a higher percentage of body fat had lower engagement[66] and 2 reported no significant association[39]. Among the 3 studies that investigated the links between diagnosis date and adherence/engagement, 1 showed that patients with an older date of diagnosis date had higher engagement[47] and the other two reporting no significant results[39,67]. The moment patients are proposed to use the intervention also seems to play a role in their engagement[44,45,62]. Only 2 studies showed no significant associations[33,67]. One study examined the association between cancer type, one study showed that breast cancer patients had higher engagement[62] while the other study showed no significant differences in engagement according to cancer type[48]. Three studies showed that treatments and medical services could be associated with engagement[42,50,53], but 1 study did not show any difference in engagement between patients who underwent chemotherapy

and those who did not[39].

Regarding psychological factors, 5 studies showed that distressed patients had higher engagement or adherence[33,44,57,69,70], 2 showed the contrary[47,50], and 3 did not report any significant results[36,39,72]. Second, 7 studies investigated the links between quality of life and adherence. One reported that patients with lower quality of life had lower engagement[44] and 2 did not report significant results[39,60]. Concerning social support, 4 studies showed that greater social support was associated with decreased adherence or engagement[44,60,69,70] and 1 showed the contrary[34]. Self-efficacy was found to be positively associated with engagement in 1 study[47], while the remaining one reported non-significant results[60]. Moreover, the 3 studies that investigated the links between information competence and adherence or engagement reported non-significant results[33,44,76]. Regarding resistance, one study showed a positive association with adherence[58], another a negative one[35] and the last no significant results[77].

Concerning intervention-related factors, the two studies that compared web-based interventions with paper pamphlets showed that participants had higher engagement or adherence with the digital version of the intervention[45,80]. Two studies compared interactive digital interventions with information-only portals. One yielded inconsistent results depending on the measure used[81] and the other non-significant results[82]. Two studies compared eHealth interventions with face-to-face ones. One showed that participants who participated in the eHealth intervention were less adherent than those who participated in its face-to-face version[78]. The other one did not show any significant differences[34]. Finally, 2 studies compared two different interactive digital interventions. One did not show any significant differences[39] while the other highlighted inconsistent results depending on the chosen measure[51]. Regarding human support the results were conflicting. One study showed that human support was associated with increased adherence[86], the other showed the contrary[64]. Finally, reminders were found to be effective in improving engagement[89,90].

Mobile-based

Eighteen articles reported on mobile-based interventions. Regarding sociodemographic factors, 2 studies showed that older patients tended to engage less with the interventions than younger ones[38,41], 1 showed the contrary[46]. Two studies reported that higher education was associated with higher engagement[38,41], 1 reported the contrary[52] and 1 yielded non-significant results[39]. Moreover, two studies showed how being from a privileged background was associated with better adherence or engagement[41,54]. Reliable trends could not be established concerning employment as 1 study showed that employed patients were also found to be more engagement than those who did not work[39], 1 reported the contrary[56] and 1 reported non-significant results[39]. One study showed that women were more adherent than men[58], and the other showed no significant association[49]. One study suggested that married patients had higher engagement[38], while the other one yielded non-significant results[39].

Regarding health-related factors, regarding comorbidity, patients with comorbidities had lower engagement in 1 study [38] and one reported non-significant associations[41]. The moment patients are proposed to use the intervention also seems to play a role in their adherence[35,52].

One showed that distressed patients were more adherent[58], 2 showed the contrary[35,71]. Two studies showed that patients with better quality of life had higher engagement[65,71], and 1 did not report significant results[56]. Positive perceptions of digital interventions were consistently associated with better adherence and engagement in the 4 studies that investigated this factor[37,46,74,75]. One study showed a positive association between resistance and adherence[58], another a negative one[35]. Regarding intervention-related factors, one study showed that participants were more adherent to the digital version of the intervention than to a paper pamphlet [79], and the other one showed no significant differences between the two types of intervention[54].

Finally, the two studies did not show any significant differences[83,84].

Quality of the included studies

The quality of the included studies could not be assessed with a standardized evaluation grid because for a number of studies, examining the factors associated with adherence was a secondary objective. Therefore, the quality of the method employed to assess this objective may not reflect the overall quality of the articles examined.

The results reported in the previous sections varied greatly, including in a same study, depending on the operationalization of the factors under study (e.g., social support vs. social constraints), their measures (e.g., dichotomization op.1--f a variable), the way adherence was conceptualized (e.g., active app days, per cent of messages read)[37], as well as the composition of the sample under investigation (e.g., samples composed of people aged 65 or older[40]). Moreover, some of these results may be imputable to other confounding variables (e.g., cancer type and gender).

Finally, it is noteworthy that 15 articles reported a non-significant association between some variables under study and adherence, without specifying which ones. This may lead to an overestimation of the effects of said variables, especially sociodemographic and health-related ones[27,35,36,54,56,60,61,69,70,77,78,82,92–94].

Discussion

This review aimed to highlight factors associated with adherence to digital interventions in cancer care. Despite the large number of articles included in this review, most results are heterogeneous across studies. For illustration, sociodemographic factors were the most investigated, but our review showed that these are the ones that have the most inconsistent results. This may be due to the heterogeneity in the types of intervention under study (i.e., duration, objective, format), the diversity of the populations included (e.g., adolescents and young adults, breast cancer patients) as well as the inconsistency in the measures of adherence (e.g., logins, time spent, self-reported measures) and its predictors. Yet, it is also important to note that some results were consistent across the majority of studies. For example, the most adherent patients to digital health were those who were older, without comorbidities with a positive perception of the intervention, and a low level of social support. Given the large number of factors covered by this review and the heterogeneity of the results, this discussion will focus exclusively on the most surprising results as well as those that were most widely agreed upon in the included studies.

Regarding health-related factors, the factor on which there is the greatest consensus is the presence of comorbidity. Indeed, the association between comorbidities and low adherence to digital health is noteworthy. Similar results have been found in previous studies in older adults and patients living with rheumatoid arthritis[95,96]. The authors highlight that some comorbidities may prevent access to digital interventions (e.g., cognitive functioning, vision problems)[96]. Another explanation for these results may be that current digital interventions in cancer care do not address the complexity of these patients' health and care journey[97]. These data suggest that the presence or absence of comorbidities must absolutely be taken into account in the conception of adequate digital interventions for cancer patients.

Regarding psychosocial factors, the results concerning the effect of distress level on adherence were surprising. While distress was found to be positively associated with adherence to digital interventions in a little more than half the studies, the results remain inconsistent across the other included articles. These contradicting results could be explained by the variability of definitions and measures of distress. In patients presenting a mental illness, adherence to digital interventions for depression and anxiety is often low to moderate and predicted by their severity[98–101]. Symptoms of such disorders (e.g., anhedonia, lack of motivation) could hinder adherence to these interventions.

In the context of cancer, we highlighted that all the studies that showed that higher distress was associated with increased adherence used cancer-specific measures of the concept. Here, the association distress may be more of an indicator of need for support regarding cancer than severe symptoms of psychological distress, or even mental illness. In other words, cancer-related distress being an indicator of cancer-related needs, the more patients report such needs the more likely they are to use digital interventions. The association between distress and adherence to digital health highly depends on how distress is conceptualized (e.g., depression, cancer-related distress, anxiety). Consequently, identifying the type and level of distress of patients is crucial to address their needs and improve their adherence to the digital interventions they are offered.

Still among the psychosocial factors, one predictor of adherence seemed to enjoy consensus in the studies included in this review: social support. More specifically, most studies have shown that low social support was associated with better adherence. This is congruent with studies that showed that cancer patients with low social support were more likely to seek health information online[102]. Connection with peers is part of the experience of digital health users and some interventions include components to foster interactions between them[31]. Indeed, they can successfully improve perceived social support in cancer patients[103]. Meeting similar people through a shared digital intervention could create a sense of community and decrease feelings of isolation[104,105]. However, not everyone is comfortable with social network features so these aspects may be less relevant for people who already have a satisfying level of social support[105]. Finally, social support has been linked to better psychosocial outcomes and self-management behaviors in patients[106–108]. Consequently, patients with high levels of social support may be less inclined to use such interventions.

The adoption of an intersectional lens allowed us to highlight specificities according to intervention goal and operationalization of adherence vs. engagement. In particular, for interventions targeting distress in cancer patients, gender might play a more important role than in other types of intervention, with women being more adherent/engaged than men. This might be explained by more negative attitudes toward mental health interventions in men[109,110]. Similarly, distressed patients seem to be more adherent to distress-focus interventions than other types of interventions. This may be explained by the relevance of such interventions to their needs. However, these results remain inconsistent across studies. Finally, when focusing on adherence rather than engagement, older patients were more adherent than younger patients. This aligns with previous research highlighting that older patients are more adherent than their younger counterparts[111].

This systematic review has limitations worth mentioning. The main one is the significant heterogeneity of the articles included in this review, both conceptually and methodologically. From a conceptual point of view, the absence of a consensus on the definition of adherence in eHealth is a major obstacle. This echoes previous research highlighting a lack of consistency on the definition of this concept in the context of digital health[17]. Due to the wide variation of terms used to refer to adherence (e.g., engagement, use, usage), some relevant studies may not have been included. From a methodological point of view, the analysis of the included studies relies on the content of the articles, yet some of them presented incomplete data (e.g., the details of the results and/or the non-significant associations with adherence were not reported). This may lead to an overestimation of the effect of some factors. Examining factors associated with adherence was the main objective of less than half of these studies which may explain the lack of details in some articles. In the future, it seems essential to better conceptualize adherence and to deepen the research into its determinants. Finally, our review included studies with patients with all types of cancers and at different stages of cancer. However, breast cancer was overrepresented in our review which may affect the external validity of our results. In future research, it could be interesting to target a particular type of cancer.

Despite these limitations, we may provide recommendations for the development of future digital interventions targeting cancer patients. In particular, personalization seems to be essential. The

platform should consider individual needs, including age, comorbidities, and distress type (i.e., cancer-specific or non-specific) and levels. It should target isolated patients to provide tailored support and address gender-specific preferences (e.g., regarding mental health). Usability and accessibility are essential, with continuous evaluation for ongoing improvement. Such an intervention would enhance patients' adherence and engagement, and ultimately, patient outcomes.

Conclusion

In summary, this systematic review examined factors associated with digital health adherence, aiming to provide a comprehensive understanding of the current state of research in this field. Our analysis revealed several key findings that shed light on the complexity of eHealth adherence. The results underscore the importance of health-related factors and psychosocial factors in predicting adherence. More specifically, the presence of comorbidities and the level of social support appear to be important factors to consider in ensuring patient adherence to digital interventions. However, our review also and above all highlighted the need for further investigation in this area, in particular by studying the effects of promising but poorly considered factors such as self-efficacy. Finally, in order to gain a clear understanding of the factors involved in adherence to digital interventions for cancer patients, it seems essential that future research should pay more attention to investigating the effects of specific features (e.g., gamification, peer-support modules), standardizing other factors (e.g., human support, comparison to other interventions), homogenization of adherence measurements and enhance the quality of their studies. For example, a significative number of studies did not report which variables they investigated when they did not yield significant results. By addressing these gaps and limitations, future research can contribute to improving digital interventions and ultimately enhance patient outcomes in this digital healthcare era.

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Figure 1: PRISMA flowchart

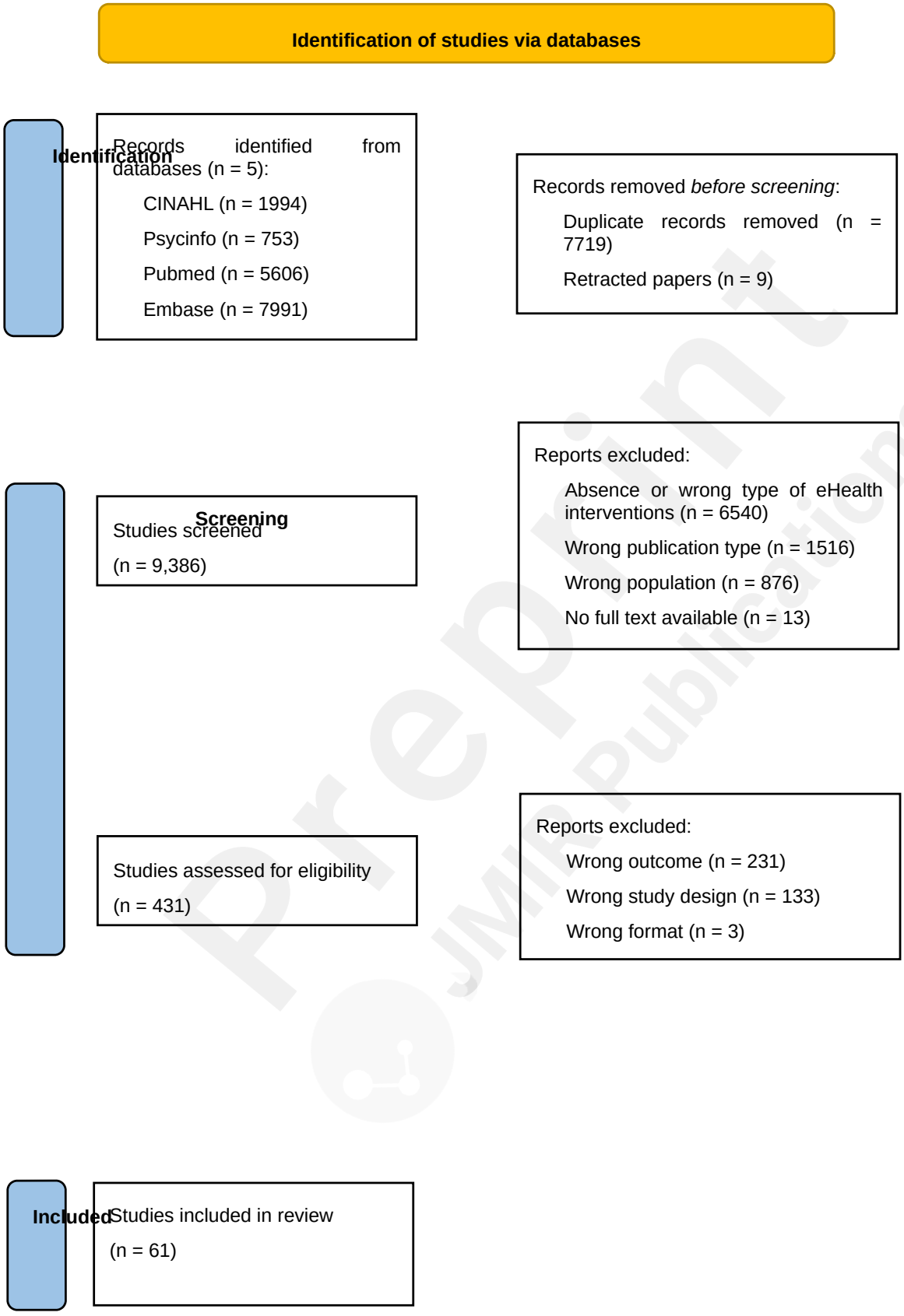

Table 1: Descriptive statistics for the included studies

	% (n)
Type of study	
RCT	50.8 (31)
Secondary analysis of RCT	24.6 (15)
Observational	24.6 (15)
% studies with a majority of breast cancer patients	67.2 (41)
% studies on cancer survivors	41.0 (25)
Adherence operationalization	
Intention	3.3 (2)
Engagement	52.5 (32)
Adherence without justification	41.0 (25)
Adherence with justification	3.3 (2)
Measures	
Combination	57.3 (35)
Drop-out rate	32.8 (20)
Time spent on the intervention	32.8 (20)
Number of log-ins	29.5 (18)
Number of actions within the intervention	24.6 (15)
Number of page views	19.7 (12)
Completion of intervention/modules	16.4 (10)
Self-reported measures of use	11.5 (7)
Number of active days/weeks	9.8 (6)
Measures of wearables	4.9 (3)
Intention to use the app	3.3 (2)
Specific measures	9.8 (6)
Type of intervention	
Web-based	63.9 (39)
Mobile-based	29.5 (18)
Other or combination	6.6 (4)
Goal of the intervention	
Distress	24.6 (15)
Nutrition and physical activity	16.4 (10)
Quality of life and symptom management	14.8 (10)
Others	23.0 (14)
Combination	19.7 (12)

Supplementary Files

Multimedia Appendixes

Search Strategies.
URL: http://asset.jmir.pub/assets/c6605b1adf6eaa660cddf09fd2b138d2.docx

Table S1.
URL: http://asset.jmir.pub/assets/0ff27aac16dcfff3ebbabe27c407a9eb.xlsx

CONSORT (or other) checklists

PRISMA Checklist.
URL: http://asset.jmir.pub/assets/c5d9b0f6360e93693629949ff0d87444.pdf