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eHealth for improving quality of life in breast cancer patients: A systematic review

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ABSTRACT

Breast cancer patients (and survivors) use to deal with important challenges daily, such as coping with stress and depression, and adopting healthy lifestyles in order to improve treatment effectiveness; moreover, some experiential issues are quite specific of this disease, such as sexuality and fertility disfunctions after hormonal therapy, and distortions in body image after breast surgery. Recent literature highlighted the utility of eHealth or the use of new technologies to promote health management and quality of life in chronic diseases generally. The present contribution aims at (1) exploring usage and effectiveness of eHealth resources to improve breast cancer patients/survivors' quality of life, and (2) describing whether existing eHealth interventions addressed specific characteristics of breast cancer, or employed a generic approach only. A systematic literature search according to PRISMA guidelines was performed. Twenty-four studies met inclusion criteria and were included. Discussion highlights a majority of encouraging results about eHealth in breast cancer patients' health management, especially in those interventions featuring eHealth tools for improving patients' abilities (e.g., coping) and complex eHealth systems with multiple resources. However, generic use of eHealth is still predominant over disease-focused solutions. Guidelines for future eHealth research and development are listed in order to promote technology design centered on the lived experience of specific illness.

Introduction

Most of the main challenges emerging from the healthcare demand worldwide regard long-term care of chronic conditions. Diseases once lethal are today treatable, but still deeply impact patients and survivors' quality of life and require continual health management even after recovery. For example, breast cancer patients and survivors have to deal with important challenges daily. Some of them are common in chronic health conditions, while other experiential issues are specific of this disease.

An important issue in chronic disease is emotional distress; the American Psychiatric Association recognized diagnosis, such as cancer, as a traumatic stressor possibly generating impairment in different areas of functioning (ability to work and social relationships) because of negative cognitions and mood [1]. Usually patients react to the disease onset and management in different ways [2] and they may develop depression and anxiety [1,3,4]. Patients often experience anxiety because of the anticipation of negative outcomes and uncertainty about the future [5]. Two groups of factors contribute to anxiety: physical (e.g., age, hormonal changes, side effects of treatment), and psychological (e.g., negative feelings about the disease, and the resistance to change one's own lifestyle to adhere to treatment prescriptions) [6].

Living with a chronic disease also has consequences on cognitive processes, for example decreases in attention, executive function, learning and memory [7]. Emotional distress is also underlined by the need to adopt a healthy lifestyle. Patients try to make changes in lifestyle postdiagnosis, for example in eating habits and management of daily appointments but sometimes there is a lack of guidance and experience of fatigue. However, not all chronic diseases are the same from a psychological point of view. For example, breast cancer patients and survivors have to confront with some aspects quite specific to their illness experience [8–11].

Breast cancer is the most common cancer in women worldwide with an estimated 1.7 million new cancer cases diagnosed in 2012, representing 25% of all cancers; it is also the most frequent cause of death for women in women aged < 55 years, representing 15% of total cancer cases [12–14].

The diagnosis of breast cancer is a stressful experience that often comes at an age when women are in the middle of career development

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or child-rearing and do not feel ready and able to face a chronic risky illness for the life [14]. These aspects, together with the emergence of negative experiences such as stress in significant relationships and negative emotions such as anxiety, anger, sadness, suffering, guilt and fear of death have notable consequences on breast cancer's women quality of life [14–16], and even in the disease progression [17].

Moreover, breast cancer patients are exposed to treatments that involve changes in their physical appearance, such as skin discoloration, dermatitis and soreness related to radiotherapy, loss or disfigurement of one or both breasts, hair loss possibly caused by chemotherapy and/or scars from surgery; in some cases, chemotherapy and hormonal therapy are associated to weight increase and early menopause [18–21]. In addition to physical appearance, the sensation of pain caused by the surgery and limitations in daily functioning have a great impact on family and social areas, including job [22,23]. All these changes can affect individuals' perception of themselves and their own body image as well [24–29]. "Body image" is a complex representation of one's own body that is the result of integration of multiple inputs, some of them coming from the perception of the body itself (*somato-perception*, influenced by body position in space, interoceptive and exteroceptive inputs), others from cognitive representation which are influenced by culture (*somato-representation* or the semantic knowledge of the body) [30]. Our bodily experience has an "online" representation (how the body is right now, egocentric frame), and an "offline" representation (how the body normally is, allocentric frame) [31,32]. Thus, there are situations in which there is no consistency between mental representation and reality regarding the body; body image disturbance is a defection of perception about oneself, generating notable distress and dissatisfaction [33].

Moreover, body image is closely linked to identity, attractiveness, self-esteem, social relationships and sexual functioning [24]. Negative emotions experienced towards one's own body can have devastating effects on self-esteem and social relationships [26,30]. Common behaviors are camouflage defects with hat or makeup, excessive grooming (e.g. hair combing) and changes of dieting and clothing, in a continuous comparison with others [34]. Indeed, the ability of a woman with breast cancer to face illness and treatment can be compromised if she is greatly worried about body image or satisfaction [25].

The dissatisfaction about one's own body can affect sexuality too. Women with breast cancer are threatened in all its dimensions: sexual identity (diagnosis can affect femininity, maternity, eroticism and social role), sexual function (e.g. loss of sexual hormones and sexual satisfaction) and sexual relationship (e.g. difficulty getting into intimacy with the partner due to the embarrassment of own body) [35].

In addition to medical aspects (e.g., sudden menopause, with concomitant symptoms that influence the sexual life such as vaginal dryness, hot flashes and sleep disturbances) patients may experience a loss of a sense of womanliness and a decrease of sexual attractiveness which can threaten the quality of the relationship with the partner [36,37]. In many cases, the fear of a sexual encounter with the partner can occur in breast cancer patients. This fear is related to insecurity on one's body resulting from changes in the sensitivity and shape of the breast and the fear that the partner does not accept these changes [38].

As a result of progress in breast cancer care, more attention is paid to the theme of fertility [38,39]. Treatments can induce a sudden menopause which makes pregnancy impossible. Furthermore, diagnosed cancer typically delays conceive: women have to delay pregnancy for a minimum of 2 years posttreatment, while those under hormonal therapy may have to wait 5 years long. During this time there will be a decline in fertility related to age and treatment duration [40].

If we consider the characteristics of breast cancer as a specific chronic conditions, interventions to improve treatment adherence, well-being and quality of life should be able to address not only the "generic" factors involved in chronic conditions, but also the irreducible experiences of having to deal with body image disturbances, sexuality issues as well as the illness-specific forms of pain.

eHealth and breast cancer

As previously shown, chronic conditions such as breast cancer require not only medical attention to the disease, but also dedicated solutions to guarantee long-term care and health management. The literature shows that this is achievable when the patient is not a passive recipient of care, rather he/she is an active manager of his/her own health; using the terminology common in patient-centered medicine of the last decades, the patient is activated [41,42], or empowered [43], or engaged [44,45]. An extraordinary resource for promoting health management and patient engagement is eHealth, an umbrella term which is typically used to refer to any usage of information technology in healthcare, usually by providing the patients with access to digital systems and/or technological devices to empower their health and well-being. From a technological point of view, eHealth interventions could feature a variety of devices and types of software, ranging from web platforms to support treatment adherence [43,46,47], web-based and digital content for promoting health literacy [48], telecommunication for enhancing patient-doctor communication [49,50], social media for peer support [51,52], single and multiplayer video games for health promotion [53–55], persuasive technologies [56,57], mHealth [58,59], to augmented reality, virtual reality and Virtual Worlds for immersive simulation and learning of health-related practices [60–62].

The research traditionally focused on eHealth's ability to improve clinical outcomes (physical and psychological), usually obtaining mixed to positive results [63–65]; then, reviews focused on eHealth effectiveness in promoting health management in chronic behaviors [66,67] and finally on its role in patient activation/engagement [61,68,69].

The literature well documented the benefits of eHealth in terms of improvement of operational efficiency, higher quality of life, and positive return on investments, fostering change in behaviors, knowledge and clinical outcomes [70]. In addition, different eHealth applications have been used across countries in reference to their priorities and health needs, improving the safety and continuity of patient care [50]. Many studies show that eHealth is effective/cost-effective and patient acceptance and satisfaction are generally considered high, but also they suggest the need of additional research to clarify efficacy and cost-related issues; recently, an important development of eHealth is linked to the implementation of mobile technologies as instruments to potentially reach any clinical population taking easiness of use and specific needs into account [71]. Another interesting aspect is the possibility to improve engagement as a crucial factor for fostering quality of care and patient safety; this is possible thanks to the effective exchanges among actors involved in the care process through eHealth [69] and have the potential of promoting self-management for the reliability of self-reporting of symptoms [72].

However, recent studies also highlighted eHealth implementations' shortcomings [73–75]. A recent review [76], which was focused on factors impacting success or failure of eHealth interventions, did not register a significant discrepancy between successful and not-successful interventions among the reviewed studies (N = 221). In a second step of the review process, focused on 23 selected articles, the authors identified the main barriers to eHealth positive implementation, the most important of them relating to the effects of health information technologies on organizational roles and practices (e.g., they bring along additional workload for the health professionals, and pose issues to a clear roles identification while managing development, implementation and evaluation of the technologies).

Another important aspect to take into consideration when considering eHealth's potentialities for promoting quality of life is that the definition of this construct itself is particularly complex. The definition of Quality of Life (QoL) is not universally accepted; it changed in the course of time, becoming more complex and enriched across a number of disciplines. It should be viewed as multidimensional, emphasizing the self-perception of the individual's current state of mind. A number of environmental, social, psychological and physical aspects are

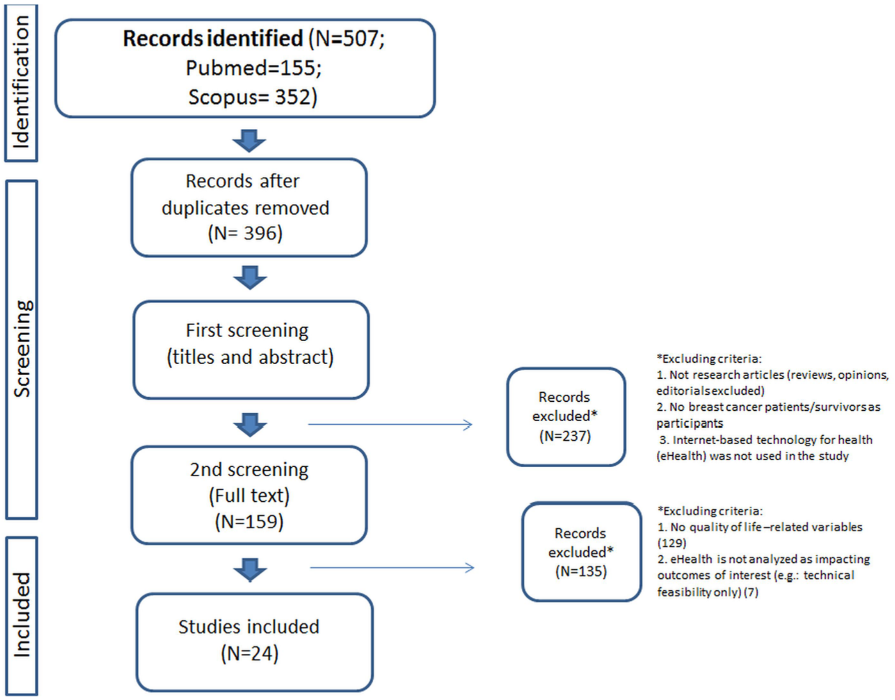

Fig. 1. The systematic review flow diagram.

involved. The World Health Organization (WHO) defines QoL as individuals' perception of their position in life in the context of values systems and culture in which they live, involving personal goals, expectations, and concerns; it is a feeling of overall life satisfaction and its appraisal is subjective, in terms of self-perceived meaning; this definition includes elements of a biopsychosocial model and it is likely to be mediated by cognitive factors [77]. Multiple aspects of everyday life are relevant, including emotional reactions to life occurrences, disposition, and satisfaction with work and personal relationships [78]. In this sense, from a measurement viewpoint, indicators of QoL could be classified as either reflective (manifestations of some underlying constructs), composite (linear combination of the indicators), or causal (effect of the indicators) [79]. Anyway, the relationship between eHealth and QoL regards the fact that new technologies have the potential to not be digital additions to therapy only, but tools for health management and promotion that are strictly embedded in everyday life and practices, continually helping patients to become active managers of their own health [61,80,81].

Although these factors are certainly fundamental, the literature is still lacking regarding the patients' attitudes towards the healthcare solutions; the links between initial acceptance, actual adoption and long-term usage of the technologies by patients are still not very clear. In virtue of that, recent approaches to eHealth implementation calls for the importance of pre-analyzing users' needs, habits, personal environments and illness experience in order to promote the design of effective eHealth in advance [69,82–84].

On these basis, it is more and more important to review eHealth studies not only for what regards their general effectiveness, but also their ability to address the characteristics of specific illness experiences. As previously said, breast cancer patients and survivors have to deal with issues typical of chronic conditions generally (e.g., stress and anxiety; struggle to adapt to new healthy lifestyles), but also with challenges specific of their condition (e.g., body image distortions, sexuality issues, illness-specific pain). It is possible that the majority of eHealth interventions are still biased towards generic aspects and do not appreciate peculiar experiences.

Objectives

The aim of the present review is two-fold:

1. To analyze usage and effectiveness of eHealth resources to improve breast cancer patients/survivors' quality of life and health management;
2. To report whether existing eHealth interventions addressed specific characteristics of breast cancer, or employed a generic approach only.

Methods

A literature review was conducted in April 2018 on two search engines (Pubmed and Scopus). This systematic review was conducted according to PRISMA guidelines (a protocol to perform systematic review) [85]. The foci of the search were "breast cancer" and "quality of life". We focused on the internet e-health related to breast cancer. So the following search string was used across both selected engines: "e-Health" OR "e-health" OR "m-Health" OR "m-health" OR "health informatics" OR "internet" OR "mobile" AND "management" OR "adherence" OR "quality of life" OR "healthy lifestyle" OR "well-being".

Only research papers published in English within 2005 and 2018 were considered.

The first screening was done on the title and abstract of 396 articles; only research articles have been considered (reviews, opinions, editorials excluded). Studies should have featured breast cancer patients as at least one experimental group; also, the employment of internet-based technologies for health management in the studies was mandatory for their inclusion. At the end of this first screening phase, 237 contributions have been excluded.

Subsequently the full text of the retrieved articles was analyzed following eligibility criteria:

1. the interventions should evaluate eHealth's effects on quality of life, or quality of life-related variables (e.g., studies have been excluded that only analyzed feasibility and technical properties of technologies);

2. eHealth has been used in interventions (e.g., studies have been excluded that analyzed patients' usage of the Internet but not its effects

Table 1
Characteristics of the reviewed studies.

Paper	Sample	Design	Objective(s)	Results	Health Literacy	Social Support	Subjective Health (physical/ psychological)	Physical activity	Pain reduction	Quality of life, Emotional well being	Depression, stress, anxiety	Self-efficacy	Coping	Body image
Gustafson et al. [106]	257 breast cancer patients	Patients randomly assigned **to one of the three** 5-month interventions: ● access to the Internet; ● access to CHESS and the Internet; ● choice among several books on breast cancer or a set of general cancer audiotapes.	To compare the benefits of access to Internet (e.g., to a variety of high-quality breast cancer sites) with a focused system of services (CHESS)	CHESS helped newly diagnosed breast cancer patients significantly augmenting their quality of life, social support and health competence. In contrast, patients received little benefit from Internet access alone	x[a]	x	–	–	–	x	x	x	–	x
Hawkins et al. [107]	370 women diagnosed with primary breast cancer	Patients **randomly assigned** to either: ● (1) 6 months Internet training and access; ● (2) 6 months access to an integrated eHealth system for breast cancer (CHESS); ● (3) a series of phone conversations with a Human Cancer Information Mentor for 6 months; ● both (2) and (3) for 6 months.	To analyze the role of the well-being factors according to Self-Determination Theory (autonomy, competence, and relatedness) in the efficacy of an intervention to improve quality of life in breast cancer patients	Combining a computer-based system of information and support with a Mentor for newly diagnosed breast cancer patients produced significantly higher quality of life than for patients given open access to and training with general internet resources for breast cancer patients	–	x	x	–	–	x	–	–	–	–
Changrani et al. [100]	68 Spanish dominant speaking immigrant women with breast cancer	Patients **randomly assigned** to: ● 48 to OSGs (Online support groups). Each group met for 90 min once a week for 30 weeks; ● 20 to a usual care control group.	To find out whether Online groups reduce depression, improve coping with pain, quality of life, and personal growth	None of the outcome measures showed statistically significant change pre-post compared to the control	–	–	–	–	x	x	x	–	–	–
Des Bordes et al. [86]	20 cancer patients (10 prostate cancer-PC and 10 breast cancer-BC survivors)	Self-administered questionnaire before, after, and 1 month after navigating the website (an online health educational tool)	To evaluate the online educational tool's potential to improve knowledge, self-management, and awareness	Participants found the website useful, helpful, and able to raise bone health awareness. The website improved bone health knowledge in both PCa and BCa survivors. There is no statistical significance in self efficacy in disease self-management	x	–	–	–	–	–	–	x	–	–

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Table 1 (*continued*)

Paper	Sample	Design	Objective(s)	Results	Health Literacy	Social Support	Subjective Health (physical/ psychological)	Physical activity	Pain reduction	Quality of life, Emotional well being	Depression, stress, anxiety	Self-efficacy	Coping	Body image
Owen et al. [96]	62 breast cancer survivors	Patients **randomly assigned** to: ● Internet-based discussion group (32); ● waiting-list control group (30).	To examine the effect and potential mechanisms of action of a self-guided, Internet-based coping-skills training group on quality of life outcomes in women with early-stage breast cancer	No main effects of treatment were observed at the 12-week follow up. However, there was a significant interaction between baseline self-reported health status and treatment, such that women with poorer self-perceived health status showed greater improvement in perceived health over time when assigned to the treatment condition	–	–	x	–	–	x	x	–	–	–
Lieberman et al. [101]	114 new members of breast cancer bulletin boards (BB)	One group with pre-post measures, 2 phases: ● At the BB join patients fill out questionnaires measuring depression, posttraumatic growth and psycho-social well-being; ● After 6 months patients fill out the same questionnaires.	BBs would prove to be effective in improving participant's quality of life as measured by a decrease in depression, an increase in psychosocial well-being and an increase in personal growth	Improvement was statistically significant in all three measures; mediators (cancer stage, clinical depression at time 1, and the number of months patients actively participated to the groups) all played a role in further analyses	–	–	–	–	–	x	x	–	–	–
Galiano-Castillo et al. [91]	81 participants who had completed adjuvant therapy (except hormone treatment) for stage I to IIIA breast cancer	Patients **randomly assigned** to: ● 8-week Internet-based, tailored exercise program (n 40); ● control group (n 41) for 8 week.	To investigate the effectiveness of a telehealth system for improving quality of life, reducing pain and fatigue, as well as their maintenance after a 6 months follow up	● Significant effects for global health status, physical functioning, role functioning, and cognitive functioning and significant effect for arm symptoms ● 6-month maintenance of effects was observed except for role functioning	–	–	–	–	x	x	–	–	–	–
Loiselle et al. [87]	250 patients with breast or prostate cancer	A pre-/post-quasi-experimental design with a **control group** (usual care) was used and data were collected at three points: At Time 1-baseline (T1), at Time 2 (T2) (1–2 weeks after the completion of the 8-	Examine the impact of an 8-week cancer multimedia informational intervention on health-related outcomes among individuals newly diagnosed with cancer	● Significant improved satisfaction with cancer information over time for women, prevented deterioration in functional quality of life and	–	x[b]	–	–	–	x	x	–	–	–

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Table 1 (*continued*)

Paper	Sample	Design	Objective(s)	Results	Health Literacy	Social Support	Subjective Health (physical/ psychological)	Physical activity	Pain reduction	Quality of life, Emotional well being	Depression, stress, anxiety	Self-efficacy	Coping	Body image
		week intervention) and at Time 3 (T3) (3 months after completion of the intervention)		marginally improved perceived oncologist informational support ● No significant differences in psychosocial adjustment among men ● No differential impact according to levels of personal resources (self-esteem, mastery, and optimism)										
Ryhanen et al. [88]	90 Breast cancer patients	Patients **randomly assigned** to: ● control group (n = 43) (usual care); ● intervention group (n = 47) (usual care + an education session with the researcher on the Internet educational tool Breast Cancer Patient Pathway program and used it for 9 months).	To evaluate the effects of the Breast Cancer Patient Pathway Program on breast cancer patient's quality of life, well-being, anxiety, chemotherapy and radiotherapy's side effects	There were no statistically significant differences in the quality of life, anxiety or side effects of treatment between the groups (both the groups improved regarding quality of life); well-being correlated inversely with side effects of therapies, while anxiety correlated positively with them	–	–	x	–	–	x	x	–	–	–
Urech et al. [81]	129 patients with cancer	65 patients assigned to intervention, 64 patients assigned to **control group**; both received first-line treatment, intervention group receive a therapist-guided web-based intervention (STREAM)	Assessed feasibility and efficacy of Web-based intervention (STREAM) in improving quality of life and reducing stress	Quality of life was significantly higher and stress significantly lower in intervention group than in controls	–	–	–	–	–	x	x	–	–	–
Quintiliani et al. [93]	10 patients with breast cancer survivors	One-group pilot study with a pre-post evaluation design of a mobile health-supported behavioral counseling	To evaluate the effects of a one-group trial with a pre-post evaluation design on engagement (use and acceptability), physiological (weight), behavioral (diet and physical activity), and other secondary outcomes	Mean weight in pounds decreased; Fruit and vegetable daily servings increased; Self-reported moderate physical activity increased in metabolic equivalent of task (MET) minutes per week	–	x	x	x	–	–	x	x	–	–

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Table 1 (*continued*)

Paper	Sample	Design	Objective(s)	Results	Health Literacy	Social Support	Subjective Health (physical/ psychological)	Physical activity	Pain reduction	Quality of life, Emotional well being	Depression, stress, anxiety	Self-efficacy	Coping	Body image
Chee et al. [102]	65 Asian American breast cancer survivors	Usability test and an expert review of the system which was based on online support groups (ICSG-AA); a **randomized controlled pilot intervention study** (35 patients used ICSG-AA and generic internet resources related to concerns/ issues of Asians americans, 30 patients used generic internet resources only)	To examine ICSG-AA's usability, and its effectiveness in improving breast cancer survivors' support care needs, psychological and physical symptoms and quality of life	The system results user friendly; the pilot study obtained mixed results, with the control group improving in support care needs and symptoms, and the intervention group reducing uncertainty. The intervention group also showed improvement in physical and psychological symptoms and quality of life when controlling for background and disease factors.	–	x	x	–	x	x	–	x	–	–
Cheung et al. [97]	39 women with metastatic breast cancer	Patients **randomly assigned** to:in-person intervention, online intervention, or in-person attention-matched control, over three phases (baseline, 1 week post-intervention, and 1 month post-intervention follow-up)	To analyze feasibility, acceptability, and preliminary efficacy of a 5 week positive affect skills intervention (LILAC: lessons in linking affect and coping)	The intervention showed good feasibility, acceptability, and retention; reductions in depression and negative affect by the 1 month follow-up are found in online intervention group and improvement in positive coping	–	–	–	–	–	x	x	–	x	–
Carpenter et al. [98]	132 breast cancer patients	A randomized waitlist-controlled trial; the intervention was evaluated using a **2 group** (intervention with access to online "coping with cancer workbook" and control × 3 time design)	To investigate the workbook effects on Self-efficacy for coping, self-efficacy for regulating negative mood, and finding benefit in the cancer experience	Increasing coping self-efficacy, specifically self-efficacy for coping with cancer and self-efficacy for regulating negative mood in the intervention group; however, difference does not attenuate in the follow up (when also waiting list had access to the workbook)	–	–	–	–	–	x	x	x	x	–
Van Den Berg et al. [94]	150 Early breast cancer survivors	**Randomized controlled trial**, 70 patients received CAU (care as usual) plus the BREATH system and 80 patients received CAU alone	To investigate whether CAU plus BREATH is superior to CAU alone.	CAU plus BREATH participants reported significantly less fear of recurrence, fatigue and distress than CAU-alone participants with a small-to-medium effect size; empowerment was not affected. Effects were not maintained during follow-up	–	–	–	–	–	x	x	x	–	–

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Table 1 (*continued*)

Paper	Sample	Design	Objective(s)	Results	Health Literacy	Social Support	Subjective Health (physical/ psychological)	Physical activity	Pain reduction	Quality of life, Emotional well being	Depression, stress, anxiety	Self-efficacy	Coping	Body image
Børøsund et al. [105]	167 patients recently diagnosed with breast cancer and undergoing treatment	Patients **randomly assigned** to the IPPC (Internet-based Patient Provider Communication Service) group, to the WebChoice (web-based using management system including IPPC) or the usual care group	To compare the effects of an Internet-based patient provider communication service (IPPC); and of WebChoice, a Web-based illness management system for breast cancer patients (IPPC included); and of usual care on symptom distress, anxiety, depression, (primary outcome), and self-efficacy (secondary outcome)	The WebChoice group reported significantly lower symptom distress, anxiety and depression than usual care group; IPPC group reported less depression symptoms of usual care group	–	–	x	–	–	–	x	x	–	–
Uhm et al. [92]	365 patient survivors	Patients received a pedometer and a mobile application to provide and monitor physical exercise; or, just a brochure with the exercises explained (**control**)	To compare the effects of mobile health (mHealth) and pedometer with conventional exercise program using a brochure on physical function and quality of life (QOL)	Physical function, physical activity, and QOL scores were significantly improved; changes were not significantly different between the two groups	–	–	–	x	–	x	–	–	–	–
Shaw et al. [103]	144 early- to late-stage cancer patients	Surveys were administered just before computer mediated support groups access and then 2 months and 5 months later	To examine how insightful disclosure within a computer-mediated support group affects breast cancer-related concerns, emotional well-being, and self-reported physical well-being	The percentage of inside words written did not predict reduced breast cancer concerns-the percentage of inside words did not predict lower levels of negative emotions for the first and second period, but was predictive for the whole time period-percentage of inside words did not improve physical well-being	–	–	x	–	–	x	x	–	–	–
Hummel et al. [111]	169 breastcancer survivors (BCSs) with a DSM-IV diagnosis of a sexual dysfunction	Patients were **randomly assigned** either to intervention group with Internet-based CBT (Cognitive Behavioral Therapy) or waiting list	To examine the effect of Internet-based cognitive behavioral therapy (CBT) on sexual functioning and relationship intimacy, body image, menopausal symptoms, marital functioning, psychological distress, and health-related quality of life	Internet-based CBT has salutary effects on sexual functioning, body image, and menopausal symptoms in BCSs with a sexual dysfunction	–	–	x	–	–	x	x	–	–	x

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Table 1 (*continued*)

Paper	Sample	Design	Objective(s)	Results	Health Literacy	Social Support	Subjective Health (physical/ psychological)	Physical activity	Pain reduction	Quality of life, Emotional well being	Depression, stress, anxiety	Self-efficacy	Coping	Body image
Batenburg and Das 2014 [99]	133 patients with breast cancer	Patients filled in questionnaires on emotional coping, psychological well-being and participation within online support community at two times (T0-baseline and T1-6 months later)	To evaluate whether individual differences in coping with emotions may moderate the effects of online support group participation on patients' well-being	Online support group participation increased emotional well-being over time for patients who scored low on emotional approach coping at T0 provided that they were highly active online.Frequent online users who actively approach their emotions experienced no change in well-being, reporting highest levels of well-being overall	–	x	–	–	–	x	x	–	x	–
Namkoong et al. [104]	177 breast cancer patients	Cross-sectional analysis of expression and reception of treatment information and emotional well-being in patients using an eHealth program with discussion group	To investigate the effects of exchanging treatment information within computer-mediated breast cancer support groups on emotional well-being, and to explore whether this relationship is moderated by health self-efficacy	Expression and reception of treatment information are not directly related to patients' emotional well-being but moderated by health self-efficacy	–	–	–	–	–	x	–	x	–	–
Lengacher et al. [95]	13 cancer survivors	Single group, pre-post test design	Test the feasibility of delivering the mobile mindfulness-based stress reduction for breast cancer program using an iPad and to evaluate its impact on symptom improvement	Improvements in psychological (depression, anxiety, stress, fear of recurrence overall and problems) and physical symptoms (less daytime sleep dysfunction, fatigue symptoms), cognitive abilities (cognitive functioning and mindfulness) and QoL (energy, emotional well-being, general health and physical health)	–	–	x	–	x	x	x	–	–	–
Hawkins et al. [109]	434 breast cancer	A **2X2 design** using the Internet-only control and Full CHESS conditions, with the other factor being provision or not of a Cancer Information Mentor. Tests are administered across	To verify whether the combined condition with both Full CHESS and Cancer Information Mentor would produce outcomes superior to those produced by either Mentor or CHESS alone on functional well-	Significant better scores are produced on Cancer Information Competence, Emotional Processing, Social Support and QoL in Mentor Intervention and full CHESS + Mentor	x	x	–	–	–	x	–	–	x	–

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Table 1 (*continued*)

Paper	Sample	Design	Objective(s)	Results	Health Literacy	Social Support	Subjective Health (physical/ psychological)	Physical activity	Pain reduction	Quality of life, Emotional well being	Depression, stress, anxiety	Self-efficacy	Coping	Body image
		three times: 6 weeks, 3 and 6 months post intervention	being, social support, cancer information competence and emotional processing	conditions; Full CHESS and full CHESS + Mentor have very similar outcomes in Information and Support Condition										
Kim et al. [110]	328 women with breastcancer	Patients were assigned to eHealth system CHESS, CHESS plus health information mentor or Internet alone (**control**)	To analyze the interplay of depression and different types of e-health interventions on breast cancer patients' perceived healthcare competence, emotional processing, and social well-being over time	Chess with mentor resulted more effective in improving emotional well-being of the more depressed patient especially	–	x[c]	–	–	–	x[c]	x	–	x	–

[a] Three items assessing patient's activeness and ability to get health information

[b] Oncologist informational support (perceived support from the health professional)

[c] Three items has been used to globally assess satisfaction with oneself, personal relationships and social support

on the outcomes of interest).

Fig. 1 includes systematic review flow along with specific information on screening phases and related values.

Results

Studies retrieval

24 articles were retained to obtain the final sample.

The information about design and characteristics of each study is reported in Table 1, according to the following thematic categories: name of first author and year of publication, sample, research design, objective(s), and results (Table 1).

Characteristics of interventions

The included studies were conducted in Europe (n = 8), US (n = 15), or Asia (n = 1). Sample sizes ranged from 10 to 434, with 4 studies having a sample under 50 participants, 5 studies between 50 and 100 participants, and 15 studies over 100. All the included studies featured breast cancer patients/survivors in the total sample or at least as one of the experimental groups, with 16 studies featuring breast cancer patients and 8 studies featuring breast cancer survivors dealing with health management. 17 studies featured at least one control group along with intervention (highlighted in Table 1), while the other 7 employed one-group within subjects designs or cross-sectional research.

Regarding eHealth, the reviewed studies confirmed that such a category could include a variety of technologies and systems. Among the reviewed studies, 6 employed a web-based platform for health management or treatment adherence (e.g., with reminders for the patients to take the medications), 5 informational websites or workbooks, 7 telecommunication with the health providers (e.g., for counseling or behavioral therapy), 7 online support groups or bulletin boards, 4 received a mobile app supporting and monitoring physical activity. Other eHealth resources existing across the literature, such as serious games for teaching healthy behaviors or Virtual Worlds, did not emerge among the studies reviewed here.

Outcome measures

Consistently with inclusion criteria, all the reviewed studies featured the analysis of variables related to quality of life and long-term health management. Moreover, the majority of the reviewed studies measured multiple variables. Table 1 includes the 24 reviewed studies and, in the columns on the right, it classifies the analyzed variables in ten main categories, namely health literacy (i.e., how much patients improved their knowledge about disease and/or treatment), perceived social support, subjective health (i.e., patients self-reported whether they felt changes in their lived health, physically or psychologically), physical activity, pain reduction, quality of life and/or emotional well-being, depression/stress/anxiety, self-efficacy in managing the disease, emotional coping and body image issues. This categorization procedure has been performed independently by two of the authors, which then resolved any disagreement through consensus.

Indeed, it is possible to highlight outcome variables (and related theoretical constructs) that were analyzed in the reviewed studies. This points to the fact that improvement of quality of life and patient engagement in health management is related, as explained in the introduction, to a number of possible changes in patients' everyday life behavior and attitude towards illness, so that various data can be tracked in order to report on interventions' effectiveness. Due to the heterogeneity of the reviewed studies, this section will focus on selected interesting patterns that could be highlighted by synthetic analysis.

Quality of life and emotional well-being with dedicated tools were the constructs analyzed by the majority of the reviewed studies (N = 21, 87.5%), while clinical states such as depression, stress and anxiety were the second (N = 17, 70.8%). Overall these variables appear positively affected by the use of new technologies, especially with technologies offering multiple resources for health management and coping.

Three of the reviewed studies [86–88] involved improvement of **health literacy** or patient's knowledge about disease and treatment; this is regarded by literature as the "cognitive" component of patient engagement and health management [69], in that reliable information (as well as the ability to find and recognize it) is proven to help healthcare decision, the adoption of healthy lifestyles as well as patients' self-efficacy in dealing with health issues [89,90].

Ten of the reviewed studies used eHealth to empower patients in specific **physical or psychological ability**, ranging from **physical exercise** [91–93] to **psycho-social life skills** [94–99]. The first ones use technology to deliver exercise programs and to assist patients in the monitoring of physical exercise goals achievements (e.g., mobile applications with pedometer) and result globally effective in their aim. In the studies focused on the empowerment of psychosocial life skills, most of the studies addressed relax and/or stress management abilities, or emotional coping directly. eHealth tools can be used to deliver materials to teach psychological skills [98] or to support communication with health providers and/or other patients to learn and exercise them [96,97] and obtain mixed to positive results across the studies reviewed here.

Seven among the reviewed studies [96,99–104] were focused primarily on **online support groups** or cancer bulletin boards so they analyzed the effectiveness of technology in providing social support to patients and investigated its effects on coping abilities, well-being or quality of life. Some of these studies obtained negative [100] to mixed results: for example, the effectiveness of online groups and social support resources to improve quality of life appeared influenced by other variables, such as perceived health status [96], cancer stage, depression, active participation to the groups [101], background and disease factors [102].

Finally, six of the reviewed studies were built around **multi-component eHealth systems**, which usually address multiple outcomes and cannot be reduced to the empowerment of specific constructs or abilities.

Børøsund and colleagues [105] compared an Internet-based system promoting communication between patients and health providers (IPPC) with another multi-component tool including tailored information and communication among patients (WebChoice), with standard care. While IPPC reduced depression in 45 patients, WebChoice also reduced distress and anxiety in 64 patients compared with usual care (58 patients).

The multi-component eHealth system CHESS (Comprehensive Health Enhancement Support System) has been evaluated in four of the reviewed studies. As described by Gustafson and colleagues [106] CHESS included Information Services (e.g., health-related web links), Communication Services (e.g., discussion groups) and Decision Services (e.g., Decision Aid, action plans). 257 participants with breast cancer received either CHESS, or links to health websites, or usual care. Results clearly showed that CHESS patients improved in all the dependent variables, namely quality of life, health care competence and perceived social support. CHESS was also evaluated in another reviewed study [107], which included two more groups, one with regular telephone calls with a human cancer information mentor and the other with the mentor again plus CHESS. This last group obtained the most positive results in quality of life measures, and the results were mediated by improvements in other measures reflecting Self-Determination Theory [108] constructs (i.e., relatedness, autonomy, competence). Another study evaluating CHESS [109] had the same design and obtained consistent results, with the CHESS plus mentor producing significant improvements in cancer information competence, emotional processing, and social support. Finally, Kim and colleagues [110] examined the interplay of depression and eHealth intervention effectiveness: CHESS plus mentor obtained positive results for what regarded healthcare competence, emotional processing and social well-being, especially for patients with highest ratings of depression.

The study by Hummel and colleagues [111] evaluated an Internet-based cognitive behavioral therapy (CBT) aimed at improving sexual functioning, relationship intimacy and body image in cancer survivors. 169 participants were assigned to experimental group or waiting list over a 24-weeks long program. The CBT group showed improvements in overall sexual functioning, sexual desire, sexual arousal, vaginal lubrication, body image, and also they reported fewer menopausal symptoms and less discomfort during sex and less sexual distress than the control group.

Discussion

Consistently with literature, it appeared from the reviewed studies that a number of heterogenous tools and technologies still fall under the aegis of the "eHealth" label; there was not some specific kind of tool which has been used in the field of breast cancer, rather the usage of multi-component online platforms, online support groups and mobile technologies was equally spread. In terms of results, eHealth technologies obtain generally encouraging outcomes in the present review, however mixed, negative or inconclusive results were also present. If we consider those studies obtaining no significant differences between groups (which usually compare a target eHealth resource with others more simple, or with usual care), it seems that they analyze quite specific resources which function alone (e.g., small online support groups: [96,100]), or technologies which seems not strongly different from their not-digital counterpart (such as LILAC, which was the same educational package administered online or in-person [97]). Similarly effectiveness of online support groups for promoting QoL, which were the specific focus of some of the reviewed articles, appears heavily influenced by pre-existent variables such as perceived health status, cancer stage and disease factors, or depression. These eHealth tools, which make use of the mediated communication and "social" properties of new technologies specifically, present tremendous opportunities especially to overcome logistic obstacles and provide patients with social support resources they can access anytime: however, the actual utility of the eHealth tool depends on patients' attitude and predisposition, rather than on the technical properties and advancement.

Consistently with recent literature on eHealth for improving well-being in cancer survivors [112], more sophisticated uses of eHealth involve technology not only to support the transmission of digital content, but to promote engagement in interactive experiences which are aimed to train patients' abilities, ranging from physical exercise to psychological skills such as emotional management.

Most effective implementations of eHealth for improving quality of life in breast cancer patients/survivors appear to be those involving multi-component online services, which make use of integrated resources to target multiple aspects of quality of life such as social support, emotions and coping, and self-efficacy in health management. For example, the CHESS system appears effective towards the improvement of a number of outcomes, especially when employed in conjunction with an expert mentor helping patients in health management via regular calls [106,107,109,110].

In general, responding to the first objective of the present review, eHealth in its complexity and variety can be regarded as a useful resource in breast cancer: multi-component interventions which make full use of different opportunities coming from new technologies (e.g., social media and online groups for social support; online platforms for organizing and managing therapy adherence; mobile apps for patients' continual monitoring; etc.) are the most effective, in that they are able to address specific quality of life issues by dedicated tools and solutions.

As a second objective of the present review, we wanted to see whether eHealth implementations appreciate psychological issues typical of specific diseases, thus developing technologies able to help patients to cope with the irreducible characteristics of their own lived illness. Quite surprisingly, only one intervention used eHealth to target specific aspects of breast cancer experience, namely body image distortions and sexuality issues [111], and only another additional study considered variations in body image representation and satisfaction as a variable important to comprehend breast cancer patients/survivors' illness [106]. This may call for an innovative principle guiding eHealth design and implementation: indeed, recent approaches observe that users' contexts and needs should be taken as a foundational guideline for design of eHealth, not only for evaluation of already-designed or implemented resources [82,113–115].

Accordingly, a possible guideline for the design of the future eHealth tools will be to employ research methods in order to capture what is important to the patients' perspective in order to improve effectiveness. Indeed, treatment adherence, social support and continual monitoring are fundamental factors to be included in eHealth design, but developers should appreciate that specific experiential characteristics affect quality of life and well-being in any chronic condition. For example, women surviving (or coping with) breast cancer have to deal with actual or anticipated effects of therapy, such as distortions of body image and sexuality issues. Future review efforts may adopt a viewpoint similar to that of the present contribution, to analyze whether other eHealth interventions are based on specific illness experiential issues, or a generic approach is still widespread in this developing field.

The present review is not extent from limitations: although two databases can be regarded as sufficient for a systematic review [116], employing more sources could allow future review efforts on similar issues to be more comprehensive; secondarily, a relatively recent time range (2005–2018) has been chosen in order to focus on eHealth technologies more representative of recent scenario, as done (or found) by similar reviews on technologies for health [69,117–119]. Future reviews could employ broader time ranges as well as alternative search strategies to explore eHealth implementations and their ability to respond to illness-specific issues.

Conflict of interest

The authors declared that there is no conflict of interest.

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