

Understanding how e-health interventions meet psychosocial needs of breast cancer patients: The pathways of influence on quality of life and cancer concerns

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Abstract

Objective: This investigation explores how using different e-health interventions facilitates positive psychosocial changes and how these changes reduce cancer concerns and improve quality of life in breast cancer patients over time.

Methods: A total of 326 breast cancer patients were randomly assigned to one of three e-health interventions: (a) Internet only, (b) the Comprehensive Health Enhancement Support System information and support services (CHESS-IS), or (c) CHESS with mentor. Proximal health outcomes such as information overload, emotional functioning, and social support were measured alongside distal outcomes like cancer concerns and quality of life. Participants completed surveys at four time points: pretest as a baseline, 6 weeks, 3 months, and 6 months.

Results: Both interventions were effective in improving patient health beyond Internet only but they differed in type of change mechanism and clinical benefit. The CHESS-IS enhanced proximal outcomes at 3 months through improved information competence. The CHESS with mentor intervention reduced breast cancer concerns at 6 months, mediated mainly by emotional-social competence and emotional functioning.

Conclusions: Using e-health interventions like CHESS can help patients improve cancer information management skills and emotional functioning, contributing to better short-term health outcomes. Adding a human mentor can enhance the benefits of CHESS use, extending the experience among breast cancer patients. Theoretical, practical, and clinical implications of the study results are discussed.

KEYWORDS

breast cancer concerns, cancer and oncology, e-health intervention, emotional and social competence, information competence, interpersonal cancer mentor, psycho-oncology, psychosocial processes, quality of life, structural equation modeling (SEM)

1 | INTRODUCTION

The American Cancer Society estimates that 276 480 new cases of invasive breast cancer will be diagnosed in women and 42 170

women will die from breast cancer in the United States in 2020.¹ Breast cancer's chronic nature and the physical and psychological challenges associated with treatment decisions and continuing management cause many patients to suffer from stress, uncertainty,

information overload, social isolation, depression, anxiety, physical pain, and discomfort.^{2,3} Breast cancer diagnosis, treatment, and management can significantly increase cancer-related concerns and damage patient quality of life.

E-health interventions offer targeted health information and support, increase patient engagement, and improve health outcomes in patients with chronic diseases, including cancer.⁴⁻¹⁰ These e-health services compliment resources provided by medical professionals and can satisfy unmet patient needs.¹¹⁻¹⁶ Previous research found that e-health interventions like the Comprehensive Health Enhancement Support System (CHESS) improved healthcare competence and future information seeking intentions in breast cancer patients after 2 months, and enhanced information competence and social support perception after five months.¹⁴ Further, Hawkins and colleagues compared the effectiveness of three e-health interventions,¹⁷ and found that the CHESS e-health with mentor intervention (ie, an NCI-trained cancer mentor) was associated with the highest perceived interactivity and social presence among breast cancer patients, followed by e-health only and Internet only, respectively.¹⁶ The study also found that CHESS improved information competence and emotional processing among breast cancer patients. After CHESS with mentor intervention use, several dimensions of quality of life were even more positively affected for breast cancer patients who were depressed.⁵ These results are consistent with a large body of literature on health coaching and its beneficial effects on chronically ill patients' physiological, psychological, social, and behavioral aspects of life.¹⁸

Perceived competence can further influence health behavior both directly and indirectly via proximal and distal intentions, outcome expectations, and perceived facilitators and challenges over the illness trajectory.^{19,20,21} Previous studies have mainly focused on examining cognitive dimensions of competence, leaving other aspects (eg, *emotional, social*) thereof underrepresented in the literature. Each competence, however, is related to different aspects of human life and produces different outcomes in different contexts. For example, higher perceived information competence was positively related to patient engagement with online social support services.²² High levels of emotional-social competence also contributed to improvements in physical, psychological, and social well-being.^{21,23-26}

While e-health interventions have generated various health benefits among breast cancer patients, few studies have examined *the mechanisms* by which cancer patients achieve these benefits. Pingree and her colleagues stressed the value of theory and recommended theory-based mediational analyses that recognize both distal goal and proximate outcomes through which effects may work: they argued that it helps to understand "why treatments work, or do not work better, and also points us in new directions for enhancing treatments (p. 103)."²⁷

This study, therefore, examines three different e-health interventions with varying interactivity and interpersonal presence to determine *whether and through what underlying psychosocial pathways* such interventions help breast cancer patients with illness management and treatment over time. We expect the greatest health benefits with an e-health intervention combined with human mentoring, followed

by e-health intervention alone, and the least benefit from unguided access to the Internet.^{16,17} We also explore the role of information and emotional-social competence to delineate the relationship between e-health intervention use and patient health outcomes.^{22,25,26} Additionally, distinguishing between proximal and final health outcomes will give us a much better understanding of intervention efficacy. In other words, this study empirically tests a conceptual model that expects perceived information and emotional-social competences to mediate e-health intervention effects on information overload, emotional functioning, and social support, and then quality of life and cancer concerns.

2 | METHODS

2.1 | Study design and participants

A total of 661 women either diagnosed with breast cancer within the last 2 months or with recurrence at the time of the study were recruited for participation in two experiments involving a total of six conditions, two shared between the experiments. Inclusion criteria were that patients were over 17 years old, not homeless, and able to read and speak English at a sixth-grade level or higher. Among them, 326 women were randomized to one of the three conditions relevant to the research questions of this study¹: Internet only as control ($n = 112$), CHESS information and support services (CHESS-IS) ($n = 109$), and CHESS with mentor ($n = 105$). The study was approved by the Institutional Review Boards (IRB approval number: 2003-192; 2003-193). See the CONSORT diagram for details about recruitment and study participation Figure S1.

2.2 | Recruitment procedures

Study participant recruitment was conducted at three hospitals or cancer centers in Wisconsin, Texas, and Connecticut. Researchers at all sites approached potentially eligible patients to ask if they would be interested in learning more about the study. Researchers reviewed the informed consent, HIPAA information, and information about the nature of the interventions in detail and answered questions from potential participants. Written consent and complete patient contact and computer access information were collected from acquiescing patients, and baseline study questionnaires were provided to them.²⁸

Once the informed consent and baseline survey were completed, participants were randomly assigned to one of the three interventions and asked about their computer and Internet needs. Computers and Internet access were provided to patients who did not have them. Participants completed a 30-minute training on how to use the intervention to which they were assigned. For Internet only, they learned how to search for and navigate relevant information online. For the other two e-health interventions, training was focused on how to use CHESS services in addition to providing a user guide and CHESS browser.^{12,14,15,16}

2.3 | E-health intervention type

2.3.1 | Internet only

Patients assigned to this condition were offered Internet access only. A list of well-known breast cancer websites was provided, but the information was not interactive, interpersonal, or customized. This resembled what most cancer patients might find when they searched for information and emotional support online on their own.

2.3.2 | CHESS-IS

The e-health CHESS-IS intervention offered interactive information and communication services to breast cancer patients. The information services included features such as "Questions & Answers" and "Resource Guide," while communication services included asynchronous bulletin boards "Discussion Group" and "Ask an Expert." This intervention enabled patients to exercise greater control over what services to use, when, and how to use them. The system also regularly prompted patients to report cancer concerns and treatment changes to allow for more individualized information.¹¹⁻¹⁵

2.3.3 | CHESS with mentor

To maximize synergistic effects between the e-health intervention use and expert help and offer individualized support, CHESS use was integrated with a personal cancer mentor.^{17,28} In addition to CHESS, patients received guidance and interpersonal support from a trained NCI Cancer Information Specialist mentor. The mentor was familiar with CHESS services and provided advice on the system per patient needs. A total of 10 calls were made to each patient during the 6-month intervention period, with conversations lasting from 5 minutes to an hour and averaging 15 minutes. Archived conversation records helped the mentor reflect on past discussions and offer tailored services to each patient.

2.4 | Key measures

Psychosocial variables were selected for their centrality and impact on cancer patients' overall health and represented cognitive, emotional, social, and multi-dimensional aspects of quality of life in breast cancer patients. The reliability and validity of these items have been empirically tested and confirmed in the health communication field.^{29,30} Individual questions for all key measures, along with scale range and reliability information, are presented in Table S1.

Information competence was measured with five questions. These questions assessed patients' perceived ability to obtain and use the health information they needed.²⁸ These items were combined to create an index for perceived information competence (pretest: $M = 2.84$, $SD = 0.71$; 6-week: $M = 3.08$, $SD = 0.67$).

Emotional-social competence was measured with eight items. These items were combined to create an index for emotional-social competence (pretest: $M = 2.66$, $SD = 0.58$; 6-week: $M = 2.65$, $SD = 0.54$).

Information overload was assessed with four items. These items were combined to create an index (pretest: $M = 1.60$, $SD = 0.67$; 3-month: $M = 1.20$, $SD = 0.56$). A higher score means greater information overload.

Emotional functioning was assessed with seven items such as, "I am able to use relaxation techniques to reduce tension I experience." These questions, adapted from the Measure of Current Status (MOCS) of breast cancer patients,^{31,32} were combined to produce an index (pretest: $M = 2.23$, $SD = 0.72$; 3-month: $M = 2.20$, $SD = 0.76$).

Perceived social support was measured with six items from the Wisconsin Social Support Scale.^{12,14} They were combined to create an index (pretest: $M = 3.39$, $SD = 0.67$; 3-month: $M = 3.24$, $SD = 0.69$).

Quality of life

The World Health Organization Quality of Life (WHOQOL) instruments were developed to assess an individual's overall life perceptions. The WHOQOL-BREF instrument comprised 11 items that broadly evaluated the social relationship and psychological health domains, along with two quality of life measures.¹⁶ These items were combined to create an overall quality of life scale (pretest: $M = 2.85$, $SD = 0.56$; 6-month: $M = 2.90$, $SD = 0.56$).

Breast cancer concerns

Nine items assessed breast cancer patients' emotional, physical, and body image concerns related to treatment and side effects from the FACT-B subscale³⁰ (pretest: $M = 1.12$, $SD = 0.63$; 6-month: $M = 1.12$, $SD = 0.68$).

Control variables

Six demographic and clinical variables served as covariates^{22,28}: age (in years), education (eight ordinal categories from "did not complete junior/middle school" to "graduate degree"), minority status as a dummy variable distinguishing "Yes (non-Caucasian)" and "No (Caucasian)," living situation as a dummy variable with "Yes (living alone)" and "No (living with partners/family)," time between breast cancer diagnosis and intervention participation in months, and pretest scores of each outcome variable to address potential confounding effects.

2.5 | Analytical framework

This investigation employed Structural Equation Modeling (SEM) with a maximum likelihood estimation using Mplus software (ver. 8) to test

proposed mediating processes. The SEM framework was chosen to provide flexibility in exploring potentially mediating relationships among different variables.³³⁻³⁵ Different fit indices were used to evaluate the overall model fit: χ^2 test, Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR), and Comparative Fix Index (CFI). CFI is about the total variance accounted by the model and values higher than .95 indicate a good model fit. RMSEA and SRMR are with regards to the residual variance and values below .05 mean a good model fit.³⁶ Only patients who completed all time points were included in the subsequent analyses.

3 | RESULTS

3.1 | Baseline characteristics

A total of 326 breast cancer patients participated in the study; mean age was 52 years and more than 50% of them held a bachelor's degree or higher. Around 13% were non-Caucasian (minority), and about 16% reported that they lived alone. The average time between cancer diagnosis and intervention participation was 2.07 months ($SD = 2.75$). There were no statistically significant differences between the intervention conditions in these demographics.^{17,28}

3.2 | CHESS-IS vs Internet-only intervention

3.2.1 | Model fit

Overall, the model fit the data well, yielding a Chi-square value of 40.98 with 42 degrees of freedom ($P = .52, n.s.$). The RMSEA value was 0.00, the CFI value was 1.00, and the SRMR for the model was 0.04.

3.2.2 | Direct effects

The CHESS-IS intervention produced significant positive effects on both perceived information and emotional-social competences after 1.5 months of intervention. However, after 3 months, only perceived information competence—not emotional-social competence or the CHESS intervention itself—was significantly associated with all proximal outcomes. Perceived information competence reduced information overload and enhanced emotional functioning and social support among breast cancer patients. At 6 months, emotional functioning had a significantly relationship with patient quality of life, and cancer concerns (see Table 1).

3.2.3 | Indirect effects

The CHESS e-health intervention improved perceived information competence, and through that enhanced competence reduced patient

information overload and enhanced emotional functioning after 3 months (see Table 1 and Figure 1 for details).

3.3 | CHESS combined with Mentor vs Internet-only

3.3.1 | Model fit

Overall, the mentor model fit produced a Chi-square value of 45.79 with 42 degrees of freedom ($P = .32, n.s.$). The RMSEA value was 0.02, the CFI value was 0.99, and the SRMR for this model was 0.05.

3.3.2 | Direct effects

Combining the CHESS and Mentor interventions was strongly associated with improved information and emotional-social competences. Perceived information competence at 1.5 months was significantly related to all three proximal outcomes at 6 months. Emotional-social competence was also positively associated with three-month emotional functioning and social support. At 6 months, only emotional functioning had a significantly positive relation with patient quality of life, and a negative relation with their breast cancer concerns (see Table 2).

3.3.3 | Indirect effects

Table 2 and Figure 2 show a series of mediating relationships for the combined intervention, working through both the 6-week competence measures and then through emotional functioning to affect one final outcome, breast cancer concerns.

4 | DISCUSSION

This study investigated whether and by which pathways an interactive e-health intervention on its own or combined with a human mentor could facilitate positive psychosocial changes among breast cancer patients, and how these changes could enhance the patients' life quality and reduce cancer-related concerns over time. Few studies have parsed the mechanisms that underlie these interventions intended to influence different health outcomes in cancer patients.³⁷

The SEM analyses revealed distinct patterns for breast cancer patients who used the two interventions. The CHESS-IS e-health intervention improved both information and emotional-social competences at 6 weeks. It also generated beneficial effects on two proximal outcomes, information overload and emotional functioning, through enhanced information competence. Patients' perceived ability to use and manage cancer information was improved after 6 weeks of intervention use, and it contributed to reduce information overload and enhance emotional functioning among breast cancer patients after

TABLE 1 Results from CHES-IS intervention vs Internet-only on the outcomes of interest (n = 178)

	Competence (6 weeks)		Proximal outcomes (3 months)			Distal outcomes (6 months)	
	Information competence	Emotional-Social competence	Information overload	Emotional functioning	Social support	Quality of life	BC concerns
CHES-IS	0.16 (0.07) [*] [2.52]	0.18 (0.06) ^{**} [2.97]	0.05 (0.07) [0.79]	-0.07 (0.07) [-1.03]	0.01 (0.06) [0.13]	0.07 (0.06) [1.12]	-0.07 (0.07) [-1.03]
Information competence	-	-	-0.46 (0.08) ^{***} [-5.74]	0.19 (0.06) ^{**} [3.14]	0.21 (0.07) ^{**} [3.16]	0.06 (0.08) [0.71]	0.01 (0.09) [0.07]
Emotional-social competence	-	-	-0.03 (0.08) [-0.36]	0.13 (0.08) [1.59]	0.14 (0.08) [1.73]	0.04 (0.07) [0.55]	0.02 (0.09) [0.27]
Information overload	-	-	-	-	-	-0.09 (0.09) [-1.01]	0.01 (0.09) [0.15]
Emotional functioning	-	-	-	-	-	0.17 (0.08) [*] [2.04]	-0.23 (0.09) ^{**} [-2.62]
Social support	-	-	-	-	-	0.04 (0.08) [0.56]	-0.07 (0.08) [-0.84]
Indirect effects	Intervention → Information Competence → Information Overload: $\beta = -0.08 (0.03)^*$ [-2.23]						
	Intervention → Information Competence → Emotional Functioning: $\beta = 0.03 (0.02)^*$ [2.02]						

Note: Coefficients are standardized betas (β). Standard errors (SEs) are reported in parenthesis. Critical ratios are reported in bracket. Only significant indirect effects are reported.

* $P < .05$.

** $P < .01$.

*** $P < .001$.

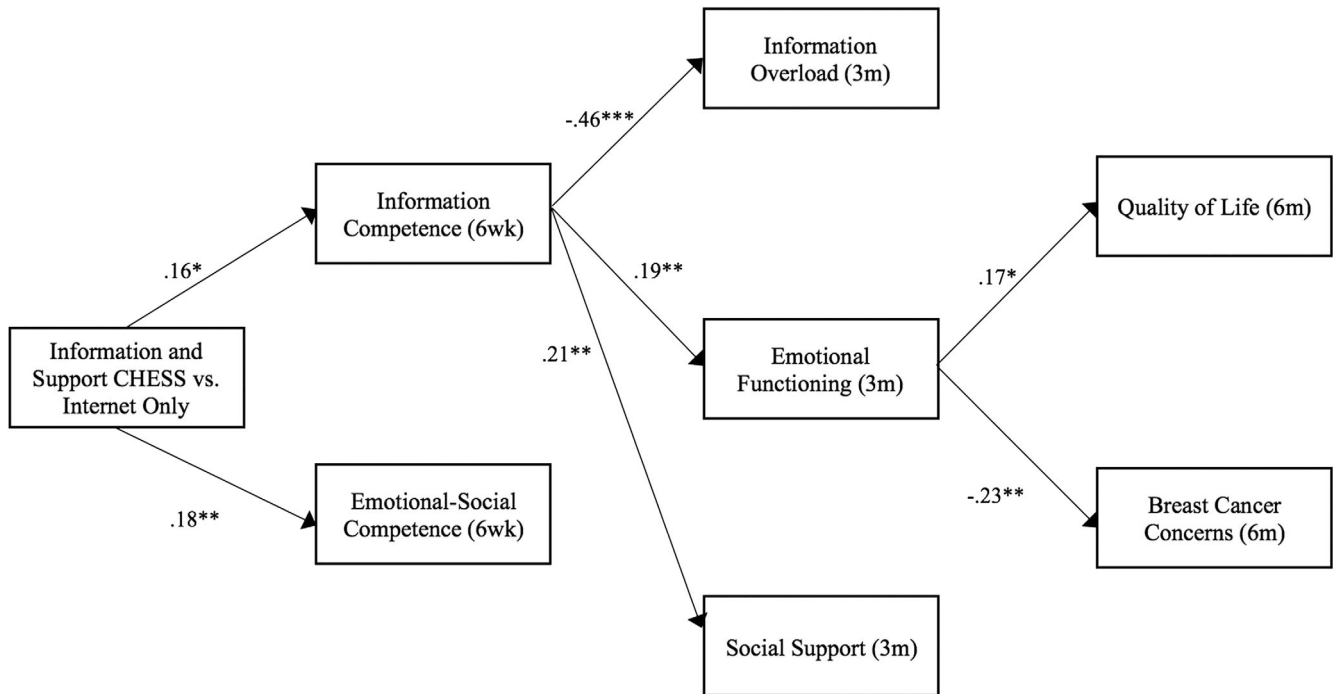


FIGURE 1 Path analysis results of CHES-IS intervention vs Internet-only on quality of life and breast cancer concerns (n = 178). Note: In the model, information and emotional-social competence at 6 weeks, information overload, emotional functioning, social support at 3 months, and quality of life and breast cancer concerns at 6 months were used. Only significant effects were presented in the figure. * $P < .05$, ** $P < .01$, *** $P < .001$

TABLE 2 Results from CHES with Mentor intervention vs Internet-only on the outcomes of interest ($n = 180$)

	Competence (6 weeks)		Proximal outcomes (3 months)			Distal outcomes (6 months)	
	Information competence	Emotional–Social competence	Information overload	Emotional functioning	Social support	Quality of life	BC concerns
<i>CHES with Mentor</i>	0.20 (0.07)** [3.12]	0.18 (0.06)** [2.91]	−0.04 (0.07) [−0.62]	−0.08 (0.07) [−1.16]	0.02 (0.06) [0.29]	0.10 (0.07) [1.52]	−0.11 (0.07) [−1.70]
Information competence	-	-	−0.36 (0.08)*** [−4.64]	0.16 (0.07)* [2.21]	0.22 (0.07)** [3.12]	−0.01 (0.09) [−0.05]	0.02 (0.09) [0.21]
Emotional-social competence	-	-	−0.06 (0.07) [−0.80]	0.21 (0.07)** [2.83]	0.18 (0.07)** [2.67]	0.05 (0.08) [0.64]	−0.002 (0.09) [−0.02]
Information overload	-	-	-	-	-	−0.004 (0.08) [−0.05]	−0.02 (0.08) [−0.23]
Emotional functioning	-	-	-	-	-	0.20 (0.09)* [2.32]	−0.36 (0.08)*** [−4.59]
Social support	-	-	-	-	-	−0.02 (0.07) [−0.26]	0.01 (0.08) [0.10]
Indirect effects	Intervention → Information Competence → Information Overload: $\beta = -0.07 (0.03)^*$ [−2.43] Intervention → Information Competence → Social Support: $\beta = 0.05 (0.02)^*$ [2.24] Intervention → Emotional-Social Competence → Emotional Functioning: $\beta = 0.04 (0.02)^*$ [2.39] Intervention → Emotional-Social Competence → Social Support: $\beta = 0.03 (0.02)^*$ [2.07] Intervention → Emotional-Social Competence → Emotional Functioning → BC Concerns: $\beta = -0.01 (0.01)^*$ [−2.08]						

Note: Coefficients are standardized betas (β). Standard errors (SEs) are reported in parenthesis. Critical ratios are reported in bracket. Only significant indirect effects are reported.

* $P < .05$.

** $P < .01$.

*** $P < .001$.

3 months. Unexpectedly, the beneficial intervention effects, did not last until 6 months to improve overall quality of life and reduce breast cancer concerns. While there were benefits of using CHES-IS evident at 6 weeks and 3 months, none was apparent after 6 months of intervention.

When CHES was combined with a human mentor, both perceived information and emotional-social competence fully mediated the effects of this combined intervention on most of the proximal (3 months) health outcomes. CHES with mentor intervention significantly improved levels of perceived information and emotional-social competence at 1.5 months. These enhanced competences, in turn, had a significantly positive impact on perceived social support at 3 months of intervention use.

Most importantly, the CHES with mentor intervention contributed to reducing breast cancer-related concerns at 6 months, through improved emotional-social competence and emotional functioning of the patients. Notably, intervention use increased patients' perceived ability to understand, manage, and share emotional and social issues related to breast cancer, and enhanced patient coping with emotional problems easing breast cancer-related concerns.^{5,17,27,28}

What is new here is the evidence that adding an interpersonal mentor to an e-health system does not just increase impact, but instead changes the way in which intervention effects occur. Using e-health interventions like CHES help patients improve cancer information and emotional social issue management skills, but it alone may not suffice to influence patient quality of life and reduce cancer-related concerns. Enhanced emotional social competence by CHES with mentor intervention played an important role in improving patients' proximal and distal health outcomes including breast cancer concern reduction after 6 months of intervention use. Thus, adding a human Mentor can enhance the benefits of CHES.

4.1 | Study limitations

The findings may only be generalizable to breast cancer patient populations that are open to using an e-health intervention. The education level of our sample was a bit higher than the national average. Also, the reliability score of information overload was low, so results involving it should be interpreted with caution. Although Internet use

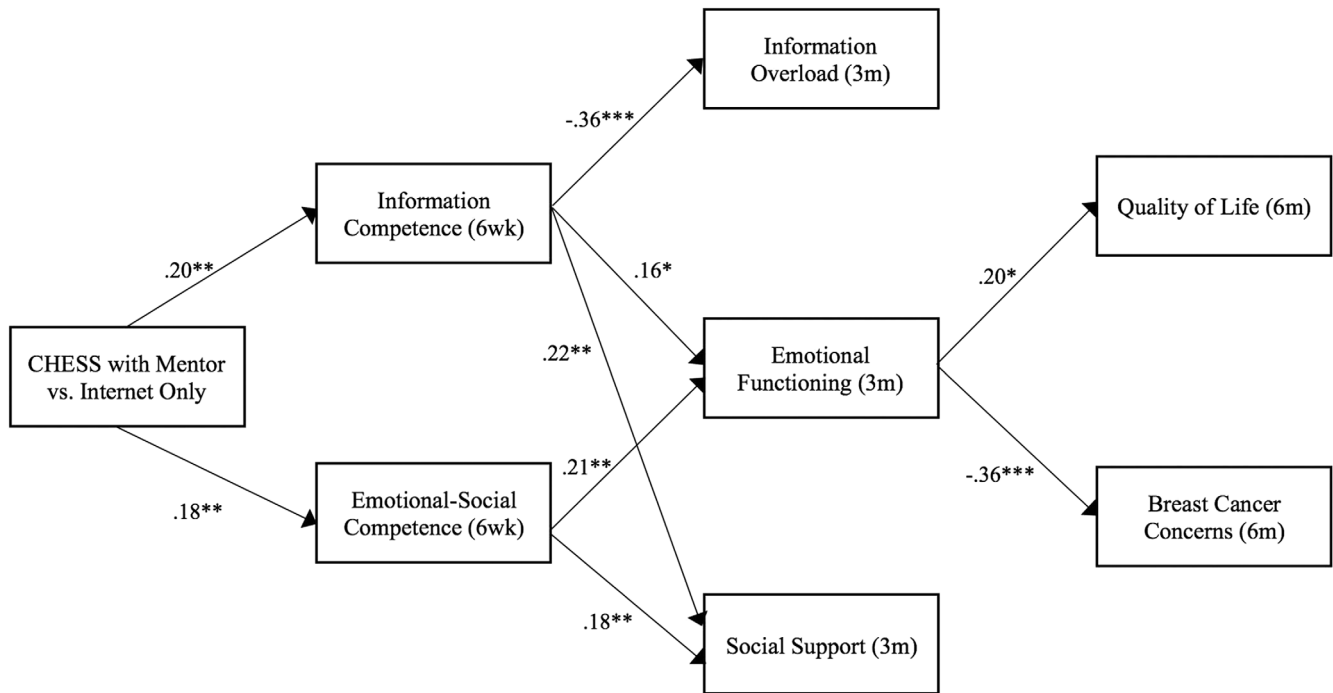


FIGURE 2 Path analysis results of CHES with Mentor intervention vs Internet-only on quality of life and breast cancer concerns (n = 180). Note: In the model, information and emotional-social competence at 6 weeks, information overload, emotional functioning, social support at 3 months, and quality of life and breast cancer concerns at 6 months were used. Only significant effects were presented in the figure. * $P < .05$, ** $P < .01$, *** $P < .001$

has become widespread for those facing health crises and e-health systems are no longer rare, more research with different patient populations, disease contexts, and intervention outlets such as m-health or games is needed.

4.2 | Clinical implications

Study findings have clinical implications for e-health intervention design and implementation. First, the study found that perceived sense of competence in dealing with cognitive, emotional, and social issues was enhanced by both the e-health only and combined interventions. However, only breast cancer patients in the combined intervention experienced reduced cancer concerns at the end of the study. Health system developers should respond by addressing breast cancer patients' varied goals.

Second, identifying and distinguishing proximal from distal outcomes can help accurately assess intervention effects and the processes by which breast cancer patients benefit from e-health interventions. Distal outcomes such as quality of life are multi-dimensional constructs influenced by many different aspects of life circumstances, whereas proximal or immediate outcomes such as information overload interface with narrower and more specific aspects of patient health.³⁸ In other words, examining how interventions work, not just whether they work, gives us far better information for improving interventions and serving patient needs.²⁷

5 | CONCLUSION

Using e-health interventions like CHES contributes to improving cancer information navigation and socio-emotional management skills, with enhanced information search skills reducing cognitive overload and facilitating better emotional functioning. Furthermore, our study results suggest that adding a human Mentor to an e-health intervention contributes to making benefits of CHES use last longer among breast cancer patients.

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CONFLICT OF INTEREST

We declare that the contents of this paper have not been published or considered for publication elsewhere. There is no financial support or relationship that may pose a conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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ENDNOTE

¹ This study analyzed a subset of a larger project; the other conditions included were (a) Information-only CHES, (b) Full CHES, and (c) Human mentor only. Past research²⁸ confirmed that CHES with only information and communication support services (CHES-IS) worked more effectively than CHES with all services, so this study compared CHES-IS with CHES with mentor intervention.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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