

# eHealth and behavioral weight loss interventions for female cancer survivors: A review

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## Abstract

Cancer survivors are at increased risk of chronic disease and diminished quality of life. The presence of overweight and obesity can exacerbate these health risks. Fortunately, even small weight losses have been found to produce clinically meaningful health outcomes. However, effective obesity treatment is difficult to access, and recently, efforts have been made to disseminate interventions using eHealth or distantly delivered technology. This review aims to focus on the efficacy and limitations of these technologies for female cancer survivors. Suggestions are also provided to encourage further meaningful work in this area.

## Keywords

cancer survivors, eHealth, females, telephone interventions, weight loss

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## Introduction

According to the American Cancer Society, there are over 8,000,000 female cancer survivors in the United States.<sup>1</sup> According to the National Cancer Institute, a person is considered a survivor from the time of diagnosis until the end of her life. A large proportion of these women are overweight or obese.<sup>2</sup> Overweight and obesity have been related to an increased risk of cancer recurrence and decreased survival.<sup>3–4</sup> In addition, compared with individuals without a history of cancer, cancer survivors have an increased risk for future cancer,<sup>5</sup> diabetes mellitus type II and cardiovascular disease<sup>6–7</sup> and may experience poorer health-related quality of life.<sup>8–9</sup>

Weight loss has been associated with a better health-related quality of life and overall well-being and a decreased risk of cardiovascular disease, type II diabetes and mortality in cancer survivors.<sup>10–11</sup> Weight loss as little as 5%–10% of body weight has been shown to result in clinically relevant health benefits.<sup>12–13</sup> In light of this evidence, the American Cancer Society<sup>14</sup> and the Institute of Medicine have advocated for research to address obesity in cancer survivors.<sup>15</sup> In fact, a few, small randomized behavioral weight loss trials among breast cancer survivors have

demonstrated at least a 5% weight loss at 6 months<sup>16</sup> with some larger trials showing 3.6% and 4.7% weight loss at 18–24 months.<sup>17–18</sup> Therefore, it is clear that clinically relevant weight loss is possible for these women.

The gold standard method for effective weight loss involves behavioral treatment, including a diet and exercise component, with in-person counseling.<sup>19</sup> An obstacle to in-person weight loss counseling is the inconvenience of having to travel to distant locations for treatment. From a health care service delivery perspective, there are

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many barriers inherent to the delivery of these intensive interventions in the context of clinical care.<sup>20</sup> For patients, the time and resources required to travel and attend such programs are often significant.<sup>21</sup> This is particularly true for cancer survivors who may need to travel significant distances to get to a medical center just to receive their cancer care. Programs that are delivered distantly may offer a distinct advantage in this regard. In particular, interventions utilizing telephone counseling or other technological approaches (such as eHealth or mHealth modalities, for example, text messages, e-mail and other Internet interfaces) may offer the repeated contacts necessary to promote both initiation and maintenance of behavior change in a diverse and growing cancer survivor population.<sup>22–23</sup> While barriers still exist to the health care system, such as staff time and the continual need to update technology, electronic and/or mobile health platforms can still hold immense promise to deliver behavioral interventions that are embedded into individuals' daily routines, that are highly personalized to individuals' behaviors and health conditions and have the potential to reach diverse populations.

Weight loss interventions that produce weight reduction of clinically relevant magnitude are only recently being developed for dissemination to cancer survivors. The goal of this review was to gain more insight into the current state of these distantly delivered interventions, specifically for female cancer survivors. Specifically, the objectives are to (1) understand current levels of efficacy, (2) evaluate current limitations and (3) provide suggestions for future work in this area to move the field forward.

## Literature available

For the purposes of this review, distantly delivered technology included the use of telephone sessions for counseling or the use of some aspect of eHealth or mHealth technology. eHealth or "electronic health" refers to any health care practice supported by electronic processes and communication, while mHealth or mobile health, a subset of eHealth, involves the use of any mobile technology, such as mobile phones and wireless sensors, to deliver and share health information.<sup>24</sup> Aside from the focus on distantly delivered technology, other goals included a decision to focus specifically on female cancer survivors and restrict review to studies that reported on behavioral interventions for weight loss versus medication or surgical procedures. Studies were included if all participants were female, had completed active cancer treatments (specifically, radiation, surgery and/or chemotherapy) and provided information on weight change in their results. Studies were not included if the manuscript was not written in English, was only available in abstract form, participants were male, or if participants were actively engaged in cancer treatment at the time of the intervention. Finally,

papers were not included if the primary form of intervention was other than telephone or eHealth technology. For example, if treatment was done in person and telephone or e-mail reminders were sent to participants, this was not considered an eHealth or telephone-based intervention. By the above definition, the search strategy identified only five papers that used some form of eHealth techniques as the primary intervention to encourage weight loss.<sup>25–29</sup> Six additional papers that used telephone counseling to deliver intervention distantly were identified.<sup>30–35</sup> All telephone-based intervention papers are described in Table 1. All eHealth/mHealth papers are presented in Table 2.

## Distantly delivered interventions

### Telephone

A total of six interventions for female cancer survivors were delivered using either group<sup>31,34</sup> or individual phone calls.<sup>30,32,33,35</sup> Women had body mass indices (BMIs) at baseline  $\geq 24$  kg/m<sup>2</sup>, were within 10 years of diagnosis and, at a minimum, had been finished with treatment for at least 4 weeks. Intervention length ranged from 12 weeks to 24 months with the intervention dose (number of phone calls planned) being much more variable. The majority of studies started with front-loading calls by providing weekly contact for the first 3–6 months, then tapering calls to bi-weekly or monthly as time progressed. The dose of contact ranged from 11 calls planned in a 6-month period<sup>30</sup> to a high of 30 scheduled in a 12-month intervention.<sup>35</sup> All of the studies, save two,<sup>31,34</sup> provided individual phone calls to women. The content of the calls was generally the same across studies with all counselors focused on diet, exercise and behavior modification techniques. Survivorship issues were reported to be a frequent source of conversation as well. Two of the studies<sup>31,34</sup> included meal replacements as part of the dietary prescription, but the remainder all required a calorie (and sometimes dietary fat) restriction along with an exercise goal generally prescribed in minutes/week of moderate to vigorous physical activity (MVPA).

All but one study<sup>34</sup> used a randomized design and had either a control or usual care group or a treatment comparison arm. Harrigan<sup>30</sup> compared individual telephone counseling to individual in-person (or usual) care; however, two other studies mixed in-person versus telephone delivery with group versus individual contact. Both Harris<sup>35</sup> and Djuric<sup>32</sup> had participants meet in person in groups, but all telephone contact was individual. Given the evidence for the superiority of group intervention,<sup>36</sup> the inconsistency of group versus individual assignment within studies makes results, at times, difficult to interpret.

The dose of the interventions was also variable; yet across the first 6 months, Harrigan,<sup>30</sup> Harris,<sup>35</sup> and Goodwin<sup>33</sup> each provided between 11 and 16 individual

calls over a 6-month period, and each obtained approximately equal weight losses of 4.8, 4.0 and 4.3 kg, respectively. This is about half of what would be expected with an in-person behavioral intervention, yet the dose of 11–16 calls is lower than the 24 in-person meetings that are typically scheduled over 6 months in an in-person program.<sup>37</sup> Therefore, the dose, not the medium of communication, may be an issue.

With regard to adherence, compliance and attrition, all studies reported a completion or follow-up rate, and only one of these studies did not report completion by treatment group.<sup>32</sup> Attention to adherence is particularly important when evaluating the benefits of new interventions or new modalities for intervention delivery. While overall study completion rates ranged from 68% to 94% across all treatment arms, completion specifically for the telephone intervention arms ranged from 68% to 91% when telephone arm attrition was compared to the other treatment arms. In the four studies where telephone arm completion was directly compared to an in-person or mail-based treatment, the telephone arm experienced greater attrition<sup>30,31,33,35</sup> and therefore lower completion rates. In the two studies that could directly compare in-person session attendance to telephone call completion,<sup>30,35</sup> attendance at in-person counseling sessions was superior with 61% and 87% attending in-person meetings where 47% and 68% completed scheduled phone calls (30 and 35, respectively).

By virtue of inclusion in this review, all studies reported on weight loss outcomes. Many studies also collected other behavioral measures, and some included biomarker or cancer symptom checklists. Outcome measures collected are listed in Tables 1 and 2, but only weight loss outcomes are enumerated here. To provide some frame of reference, effective behavioral interventions produce approximately 9 kg of weight loss over a 6-month period<sup>37</sup> and, as stated previously, clinically relevant weight loss can be obtained with body weight reduction as little as 5% of baseline. In the in-person Intensive Lifestyle Intervention arm of the Diabetes Prevention Program, participants lost an average of 6.8 kg, 7.2%, after 1 year of intervention.<sup>38</sup> Weight losses in the telephone arms of the cancer survivor studies ranged from 4.0 to 11.6 kg over 6 months. Excluding the 11.6 kg in the Befort<sup>34</sup> study which was obtained partially using meal replacements, the losses range from 4.0 to 8.0 kg. These losses are then somewhat lower than what could be expected with the “gold standard” in-person intervention but are comparable and likely approach clinical relevance. When phone interventions were compared to usual care or mail-based treatment arms, phone-based interventions were always superior either at producing more weight loss or at maintaining more weight loss. The only exception to this is the Harris<sup>35</sup> study where subjects in the phone arm *continued to lose weight* during the maintenance phase of the intervention where the in-person

group gained 1.3 kg. This difference approached statistical significance ( $p = .056$ ).

### eHealth/mHealth

A total of five papers used eHealth or mHealth interventions to encourage weight loss in female cancer survivors. Of these five papers, two were pilot and feasibility studies (25, 27;  $n = 60$  between them), one was a single-arm pre-post design (26,  $n = 30$ ) and two were randomized controlled trials (RCTs; 28, 29;  $n = 121$  between them). Therefore, over five studies, only 211 survivors have participated. Nevertheless, these five studies represent a diversity of eHealth techniques.

Participants in these studies were all, save one,<sup>28</sup> breast and/or endometrial cancer survivors who were all at least 9 months but not more than 10 years from diagnosis and had completed treatment at least 6 months prior to the trial starting. Mean BMI ranged from at least 25 to 45 kg/m<sup>2</sup>; one trial included only young (21–39 years) survivors<sup>28</sup> with one recruiting only African American women.<sup>29</sup>

The length of the studies was much more variable than the telephone-based studies. Due to the pilot and feasibility nature of these studies, treatment length ranged from 4 weeks to 6 months with only one study being as long as 24 weeks.<sup>26</sup> The interventions themselves were equally diverse, thus making comparisons difficult and overall conclusions preliminary. Two interventions used e-mailed lessons and feedback,<sup>27,29</sup> one used tailored text messages,<sup>26</sup> one provided participant input and advice via Facebook<sup>28</sup> and one delivered the intervention via phone yet had subjects report dietary intake using text messages while weight and physical activity were obtained with wireless devices.<sup>25</sup> The use of technology then was mixed both across and within the studies available. As stated previously, only two of the five studies offered any kind of comparison group, and both of these used a technology-based comparator. In Valle,<sup>29</sup> e-mailed lessons with tailored feedback were compared to e-mailed tailored lessons with an activity tracker, thus isolating the benefit of offering an activity tracker. In another study by the same research group, Valle,<sup>28</sup> Facebook was used as the medium through which study staff provided intervention delivery in the form of behavioral guidance, goal setting and self-monitoring, and this was compared to a Facebook self-help group that received basic, generic messages and links to resources. Therefore, instead of isolating the value of Facebook, the study evaluated the benefit of a behavioral intervention versus non-specific advice. All other studies used a one-arm, pre-/post-design.

In terms of adherence and completion rates, overall study completion ranged from 70% to 100% of subjects with study duration not having an appreciable impact as the 70% follow-up in McCarroll<sup>27</sup> was delivered over a 4-week time frame where Spark<sup>26</sup> ran a 6-month trial with

**Table 1.** Distantly delivered interventions.

Author/country	Design	Participants	Intervention	Completion rate/adherence to program goals	Outcomes
Harrigan et al. <sup>30</sup> United States	RCT: Three arms Telephone counseling vs IP vs UC	N = 100 Breast cancer survivors; BMI ≥ 25 kg/m <sup>2</sup> ; ≤ 5 years from diagnosis	Duration: 6 months Description: 11, 30 min IP or phone counseling sessions focused on diet, physical activity and behavior modification. UC provided brochures and referred to survivorship clinic.	Completion rate IP: 30/33 (91%) Phone: 24/34 (71%) UC: 31/33 (94%) Attendance at counseling sessions IP: 61% Phone: 47%	Outcomes measured: Weight loss, body composition, physical activity, diet, serum biomarkers Weight loss IP: -5.6 kg Phone: -4.8 kg UC: -1.7 kg IP vs phone, <i>p</i> = .46; IP vs UC, <i>p</i> < .001 Phone vs UC, <i>p</i> < .009 Outcomes measured: weight loss, serum lipids, blood glucose, BMI, waist circumference Weight loss 6 months IP: -3.3 kg Phone: -4.0 kg <i>p</i> = .98 Weight change 6–12 months IP: +1.3 kg Phone: -1.0 kg <i>p</i> = .056 Outcomes measured: weight loss, program costs, cost- effectiveness Weight loss 6–18 months Phone: +3.3 kg Newsletter: +4.9 kg <i>p</i> = .03 % weight lost 0–18 months Phone: -10.6% Newsletter: -9.3% <i>p</i> = .03
Harris et al. <sup>35</sup> United States	Quasi-experimental pilot study with randomization to two arms; Group-based IP vs individual phone	N = 52 Breast cancer survivors; BMI ≥ 25 and ≤ 45 kg/m <sup>2</sup> ; 2–36 months post-treatment	Duration: 12 months Description: IP 16 group meetings over 6 months, then monthly phone calls from 6 to 12 months. Telephone weekly contact for 6 months, then monthly from 6 to 12 months. Focus on physical activity, diet and behavior modification.	Completion rate: 12 months IP: 26/30 (87%) Phone: 15/22 (68%)	
Befort et al. <sup>31</sup> United States	Two-phase trial with randomization to weight maintenance arms after Phase I weight loss Bi-weekly group phone vs mailed newsletter	N = 210 in Phase I weight loss N = 172 in Phase II maintenance (those losing ≥ 5%) Post-menopausal breast cancer survivors residing in rural areas; BMI ≥ 27 and ≤ 45 kg/m <sup>2</sup> ; diagnosed within 10 years and < 3 months since last treatment	Duration: Phase I 6 months; Phase II 12 months Description: Phase I, 25 weekly group phone counseling sessions focused on diet, physical activity, behavior modification and meal replacements; Phase II, 26 bi-weekly conference calls vs 26 bi-weekly mailed newsletters.	Completion rate: 18 months Phone: 76/87 (87%) Newsletter: 78/85 (92%) Attendance at phone sessions: 16 sessions out of 26; 60% attended > 75% sessions.	

Table 1. (Continued)

Author/country	Design	Participants	Intervention	Completion rate/adherence to program goals	Outcomes
Goodwin et al. <sup>33</sup> United States	RCT: Two arms Mail-based intervention vs telephone-based lifestyle intervention	N = 338, post-menopausal breast cancer survivors; diagnosed within 36 months and receiving letrozole; ≤4 weeks since last treatment; BMI ≥24–40 kg/m <sup>2</sup>	Duration: 2 years Description: Mail-based received written material at baseline and 1 year; telephone-based received individuals call from a health coach weekly for first 4 weeks, bi-weekly 2–3 months; monthly 4–6 months; bi-monthly 7–12 months and every 3 months 13–24 months. Calorie restriction and exercise goal of 150–200 min/week	Completion rate: 279/338 (83%) Mail: 144/167 (86%) Telephone: 135/171 (79%) 62% completed all phone calls	Outcomes measured: Weight loss, physical activity, diet, quality of life, safety Weight loss (kg) Phone: Mail: 6 months -4.3 to 0.6 12 months -4.5 to 0.6 18 months -3.8 to 0.8 24 months -3.1 to 0.3 p = .001
Befort et al. <sup>34</sup> United States	Pilot study: One-arm pre-post design	N = 34 Rural, post-menopausal breast cancer survivors; ≤75 years; BMI 27–45 kg/ m <sup>2</sup> ; ≥3 months since last treatment	Duration: 24 weeks Description: Calorie controlled with meal replacements; 225 min/week of physical activity; group delivered weekly phone intervention calls focused on behavioral skills and survivorship	Completion rate: 31/34 (91%) 91% session attendance for completers	Outcomes measured: Weight loss, BMI, waist circumference, physical activity, diet, serum biomarkers, breast cancer symptoms, fatigue, depression, body image -11.6 kg weight loss -12.8% weight loss
Djuric et al. <sup>32</sup> United States	Pilot Four-arm RCT: Control vs WW vs WW + Individual (WW+) vs Individual	N = 48 Breast cancer survivors, diagnosed with in 4 years, ≥3 months since last treatment, ≤70 years old; BMI ≥30 kg/m <sup>2</sup>	Duration: 12 months Description: Control received pamphlets; WW attended WW meetings and reported weight to study; individual received phone calls from study RD weekly for 3 months, bi-weekly 3–6 months, monthly 6–12 months; WW + individual got calls and WW meetings. Calorie and fat restriction, 30–45 min/day exercise goal	Completion rate: 39/48 (81%) Session attendance WW: 76% 0–3 months; 50% 3–6 months; 28% 6–12 months WW+: 93% 0–3 months; 79% 3–6 months; 52% 6–12 months Call completion Individual: 10; 0–3 months; 6; 3–6 months; 10; 6–12 months WW+: 10; 0–3 months; 7; 3–6 months; 12; 6–12 months.	Outcomes measured: Weight loss, diet, physical activity, BMI Weight loss at 12 months: Control: +0.85 kg WW+: -9.4 kg* WW: -3 kg** Individual: -8 kg***

RCT: randomized controlled trial; IP: in-person; UC: usual care; BMI: body mass index; WW: weight watchers; RD: Registered Dietitian.

\*Significantly different than control; \*\*not significant; \*\*\*significant loss from baseline.

**Table 2.** eHealth/mHealth interventions.

Author/country	Design	Participants	Intervention	Completion rate/adherence to program goals	Outcomes
Quintiliani et al. <sup>25</sup> United States	Pilot study: One-arm pre-/post-evaluation	N = 10, breast cancer survivors; ≥6 months since last treatment; BMI ≥25 kg/m <sup>2</sup>	Duration: 10 weeks Description: Counselor-delivered intervention with mHealth components—Self-monitoring of dietary behaviors via daily text messages, wireless devices to automatically track weight and steps and technology-assisted phone interview sessions	Completion rate: 10/10 (100%) Step recording via fitbit: 91% days Self-weighting: 64% days Text message responses: 86% days Phone call completion: 100%	Outcomes measured: Weight loss, engagement, diet, exercise Weight loss: -1.7 kg
Valle et al. <sup>28</sup> United States	RCT: Two-arm Facebook vs Facebook self-help	N = 86, young (age 21–39 yrs) cancer survivors <sup>a</sup> ≥1 year from diagnosis; post-treatment; BMI 20–45 kg/m <sup>2</sup>	Duration: 12 weeks Description: Goal of 150min MVPA; Facebook and Internet materials provided with weekly structured behavioral guidance; goal setting, self-monitoring, moderated discussion prompts vs Facebook self-help: Links to resources and basic PA messages sent	Completion rate Facebook: 32/45 (71%) Facebook self-help: 34/41 (83%) Reading Facebook messages: Facebook + guidance: 63% Facebook self-help: 79%	Outcomes measured: Weight loss, physical activity, feasibility, quality of life Weight loss: Facebook + -2.1 kg vs Facebook + guidance self-help -0.1 kg, p=ns.
Valle et al. <sup>29</sup> United States	RCT to prevent weight gain: Intervention (Int) vs intervention + activity (Int+) vs control	N = 35 African American breast cancer survivors; diagnosed within 10 years; BMI 20–45 kg/m <sup>2</sup> post-treatment	Duration: 12 weeks Description: Goal of 150–225 MVPA/wk; 100-calorie deduction daily; wireless scale to self-monitor weight; e-mailed lessons; tailored feedback; additional dietary reduction if weight gain; Int + group also got an activity tracker	Completion rate Int+: 11/11 (100%) Intervention: 13/13 (100%) Control: 9/11 (82%) Self-weighting: Int+: 92% days Int: 63% days Control: 7% days PA adherence: INT+: 96.4%	Outcomes measured at 3 and 6 months: Weight loss, diet, physical activity Weight loss 0–6 months: Int+: -1.0 kg Int: -0.2 kg Control: +0.2 kg p=.058 Intervention groups vs control
McCarroll et al. <sup>27</sup> United States	Pilot study: One-arm pre-/post-evaluation	N = 50 Overweight or obese endometrial or breast cancer survivors; diagnosed within 3 years; ≥6 months since last surgery; BMI ≥25 kg/m <sup>2</sup>	Duration: 4 weeks Description: Mobile LoseIt! App was used for weight loss; carbohydrate restriction to <70 g/day; fiber 30 g/day; MVPA ≥150 min/week; provider feedback given by e-mail, phone, or automated response.	Completion rate: 35/50 (70%)	Outcomes measured: Weight loss, waist circumference, diet, physical activity, quality of life, self-efficacy Weight loss: -2.3 kg
Spark et al. <sup>26</sup> Australia	Single-arm pre-/post-evaluation of text-message-based weight loss maintenance intervention	N = 30 Overweight and obese breast cancer survivors; diagnosed 9–18 months prior; BMI 25–40 kg/m <sup>2</sup> ; completed Phase I weight loss intervention	Duration: 6 months with follow-up 6 months post-maintenance intervention. Description: Tailored text messages based on SMART goals negotiated individually with participants; messages delivered on schedule determined by participant with ≥21 messages/6 months	Completion rate: 25/30 (83%) at 6 months 23/30 (77%) at 6 months follow-up 74 texts received over 6 months (range 25–135) Goal checks ranged from 67% to 20% response depending on type of goal set	Outcomes measured: Weight loss, physical activity, diet, acceptability Weight loss: -6.8% after Phase I +1.6% after 6 months maintenance -5.2% loss retained after 6 months follow-up

BMI: body mass index; RCT: randomized controlled trial; MVPA: moderate to vigorous physical activity; PA: Physical Activity; SMART: Specific Measurable, Achievable, Results focused, Time bound.  
<sup>a</sup>Excluded non-melanoma skin cancer

83% completion. Most studies reported on some process measures, therefore making the goal of feasibility and acceptability a bit easier to assess. Adherence to program goals appeared generally high, ranging from a low of 64% of participants reporting meeting self-weighting goals in the Quintiliani study<sup>25</sup> to over three quarters meeting step recording, self-weighting, text message and Facebook goals in other studies.<sup>26,28,29</sup>

While attrition appeared to be low and overall adherence appeared to be high, the weight losses reported in these five studies were far less than observed in the telephone-based trials reviewed above. However, this is possibly due to the drastically reduced intervention length. With one exception,<sup>26</sup> all of the eHealth/mHealth studies were no longer than 12 weeks or about half of the length of time the phone-based studies ran. Weight losses in the reviewed eHealth/mHealth studies ranged from 0.2 to 2.3 kg. This is approximately half the weight loss of the telephone trials in half the time. Although it is not accurate to predict that longer trials would result in enhanced weight loss, this typically happens<sup>39</sup> and should certainly be evaluated in the future.

## Discussion

The stated purpose of this review was to evaluate the efficacy and current limitations of distantly delivered and eHealth/mHealth interventions for weight loss in female cancer survivors. Through this evaluation, suggestions for future directions can be provided. In terms of efficacy, the findings from the telephone-based studies reviewed are similar to what has been reported in reviews for primarily in-person weight control interventions in cancer survivors in which studies were primarily in person.<sup>16,22,23,40</sup>

Additionally, the results of the telephone-based interventions concur with those done in the general population.<sup>41,42</sup> As such, there is considerable support for the efficacy of telephone-delivered interventions among female cancer survivors. However, questions remain. Specifically, issues needing further study and examination include dose (Would more phone calls be better?); intervention delivery (Is one-on-one better than group?); factors that influence adherence and compliance (Why are participants more likely to attend in-person meetings than phone calls given the inconvenience of meeting in person?) and timing of phone calls (Is it better to use phone-based interventions for maintenance or initiation of weight loss?). Despite these remaining issues, telephone-based interventions produced consistently more weight loss than usual care or mail-based programs. For this reason alone, they are a valid and easily disseminable technique for distant delivery of weight loss interventions.

By contrast, there was a notable lack of studies using eHealth or mHealth technologies that were not merely pilot and feasibility studies. So not only were there few

completed studies to evaluate but they were very small in scope and sample size. The lack of studies using some sort of eHealth or mHealth technology was surprising, particularly when there has been a dramatic increase in weight loss trials for the general population using newer communications methods.<sup>43-45</sup> The inclusion of pilot studies which are generally underpowered at least highlights the ongoing research in this field. Studies that are adequately powered to detect hypothesized effects are certainly needed. Moreover, based on the studies available, it is difficult to discern which technologies (text messages, e-mail, wireless scales and activity monitors) or combinations of technologies are most meaningful. Studies that have enough statistical power or are designed a priori with multiple treatment arms to deconstruct the relative contribution of each of these technologies are important and will move the field forward.

Another limitation of the eHealth/mHealth studies is the very short duration of most. The lack of evidence for long-term maintenance of weight loss highlights an opportunity for future intervention and investigation of the potential value of distantly delivered technologies. Similar to adults without cancer, it is likely that cancer survivors will face challenges to maintaining weight loss<sup>46</sup> Distantly delivered intervention modalities appear ideal as they have the potential to offer a cost-effective and more easily accessible means of delivering the repeated contacts necessary to sustain behavior change.<sup>40,41</sup> In fact, two of the studies reviewed used either the telephone<sup>31</sup> or text messages<sup>26</sup> as a way to specifically discourage weight regain after weight loss. Both were successful in facilitating weight maintenance and suggest a valuable contribution of distantly delivered technologies. Moreover, in the study by Harris and colleagues,<sup>35</sup> the phone-based group maintained better weight loss than the in-person participants from months 6 to 12 of intervention again, suggesting a valuable use for distantly delivered technology as a way to sustain contact with survivors after treatment ends.

One aspect of distantly delivered technologies that needs further scrutiny is the issue of cost-effectiveness. Analysis of costs associated with intervention delivery or cost-effectiveness is rare. While less weight loss may be produced using various versions of technology, more women can be reached and perhaps at a significantly reduced cost compared to in-person interventions. Befort et al.<sup>31</sup> performed a cost-effectiveness analysis of a group-based phone intervention (26 sessions) but compared it to a much lower dose (10 sessions) mail-based intervention. It is not then surprising that the group phone-based program costs more per participant even considering the large difference in amount of weight lost between conditions. However, previous cost-effectiveness analyses of an Internet-delivered weight loss program compared to an in-person intervention did find significant savings attributable to the Internet-based intervention.<sup>47</sup> This suggests that

when “apples” are compared to “apples,” technology may generally prove to be more cost-effective. However, these studies need to be done on cancer survivors as well as the general population.

Finally, rapid advances in technology provide endless opportunities and also significant challenges. In the time from funding acquisition to RCT completion, a technology deemed to be “effective” may be nearly obsolete—or have changed enough to require complete restructuring of an intervention. It is also the case that continual advances in eHealth or mHealth modalities present barriers to technology compatibility between participants and protocols. Therefore, while the digitizing of health care presents exciting opportunities for dissemination and reach, there are practical considerations that are often overlooked.

## Conclusion

In summary, distantly delivered weight loss programs may provide a means to meet the needs of a growing and disparate group of cancer survivors and, based on the findings from this review, have potential to facilitate weight loss and maintenance of weight loss. It is important to note, however, that the vast majority of studies have been done on breast cancer survivors, therefore limiting these conclusions primarily to this subgroup of survivors. Moreover, the link between weight loss and actual improvement in survivorship has yet to be firmly established. Despite this, the growing body of evidence supports the continued investigation of eHealth and mHealth techniques. The overall strength of the current phone-based literature suggests that this modality is currently preferable for weight loss, at least until more is known about the efficacy of other technologies. Future research should continue to evaluate issues of dose, timing and adherence. Isolating specific types of technologies and evaluating cost-effectiveness are also very important. Finally, when these questions are answered, attention should turn to the integration of these methodologies into clinical care and survivorship programs.

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