



# Acceptance- and mindfulness-based techniques for physical activity promotion in breast cancer survivors: a qualitative study

Michael C. Robertson<sup>1,2,3</sup> · Emily Cox-Martin<sup>4</sup> · Yue Liao<sup>5</sup> · Sara A. Flores<sup>6</sup> · Ross Shegog<sup>2</sup> · Christine M. Markham<sup>2</sup> · Kayo Fujimoto<sup>2</sup> · Casey P. Durand<sup>2</sup> · Abenaa Brewster<sup>7</sup> · Elizabeth J. Lyons<sup>8</sup> · Karen M. Basen-Engquist<sup>1</sup>

Received: 26 May 2021 / Accepted: 11 July 2021 / Published online: 27 July 2021  
© The Author(s), under exclusive licence to Springer-Verlag GmbH Germany, part of Springer Nature 2021

## Abstract

**Purpose** The purpose of this study was to develop and characterize the relevance and potential utility of an electronically delivered acceptance- and mindfulness-based approaches to physical activity promotion for insufficiently active breast cancer survivors.

**Methods** The acceptance- and mindfulness-based physical activity intervention was delivered to participants electronically over the course of 4–8 weeks. It consisted of didactic videos, experiential exercises, and workbook-type activities that targeted principles from acceptance and commitment therapy (ACT). We conducted semi-structured, in-depth interviews with participants after they completed the intervention. Three coders conducted qualitative data analysis on interview transcripts to identify overarching themes and subthemes.

**Results** We recruited 30 participants. Of those, 16 engaged in an individual interview. The mean age of the sample was 58.4 years (SD = 13.8). The sample was relatively well educated (50.0% college graduates) and mostly overweight or obese (58.8%). We identified two overarching themes from interviews. They were centered on (1) internal and external barriers to physical activity adherence and (2) the utility of targeting core ACT processes (acceptance and defusion, mindfulness, and values clarification) for physical activity promotion.

**Conclusion** Intervention content was perceived to be acceptable, relevant, and to fulfill important needs related to healthy living. Findings suggest that this approach to physical activity promotion can be delivered effectively online. Electronically delivered acceptance- and mindfulness-based approaches hold promise for helping insufficiently active breast cancer survivors increase physical activity.

**Keywords** Acceptance and commitment therapy · Behavioral Sciences · Cancer survivors · Exercise · Mindfulness · Oncology

✉ Michael C. Robertson  
mcrobert@utmb.edu

<sup>1</sup> Department of Behavioral Science, The University of Texas MD Anderson Cancer Center, 1515 Holcombe Boulevard, Houston, TX 77030, USA

<sup>2</sup> Health Promotion & Behavioral Sciences, The University of Texas School of Public Health, 1200 Pressler Street, Houston, TX 77030, USA

<sup>3</sup> Division of Rehabilitation Science, The University of Texas Medical Branch At Galveston, 301 University Boulevard, Galveston, TX 77555, USA

<sup>4</sup> VA Puget Sound Health Care System, 9600 Veterans Dr SW, Tacoma, WA, USA

<sup>5</sup> College of Nursing and Health Innovation, The University of Texas At Arlington, 411 S Nedderman Dr, Arlington, TX 76010, USA

<sup>6</sup> Department of Health and Kinesiology, Texas A&M University, College Station, TX 77843, USA

<sup>7</sup> Department of Clinical Cancer Prevention, The University of Texas MD Anderson Cancer Center, 1515 Holcombe Boulevard, Houston, TX 77030, USA

<sup>8</sup> Department of Nutrition and Metabolism, Medical Branch At Galveston, The University of Texas, 301 University Boulevard, Galveston, TX 77555, USA

## Background

Authoritative sources have put forth guidelines for physical activity for cancer survivors [1–3], but most do not meet recommended levels [4]. Existing intervention approaches may not be ideally suited for addressing this pressing public health challenge. Physical activity interventions in cancer survivors have tended to produce small effect sizes for physical activity initiation [5], and mixed results for increasing long-term physical activity adherence [6]. Only a few behavior change techniques (BCTs) reliably predict physical activity outcomes (e.g., establishing outcome expectations) [5]. Further, one of the most commonly used BCTs, *prompt barrier identification* (defined as “identifying barriers to performing the behavior and planning ways of overcoming them” [7, 8]), has been shown to *negatively* predict physical activity outcomes in cancer survivors [5].

While identifying planning ways of overcoming salient barriers may be useful for increasing physical activity in some contexts, it appears that this approach may be limited in the context of increasing physical activity for cancer survivors. This may be due in part to the nature of cancer survivors’ barriers to physical activity. In addition to the barriers encountered by the general population (e.g., lack of time and motivation), cancer survivors can also face marked internal barriers to physical activity attributed to cancer and its treatment. These can include fatigue, pain, and frustration due to physical limitation and decreased physical functioning [9–12]. Increasing physical activity in the presence of challenging internal barriers such as these may require a different approach than the standard approaches taken by most current physical activity interventions.

Acceptance- and mindfulness-based approaches to physical activity promotion may be a better fit for cancer survivors. Acceptance- and mindfulness-based approaches to behavioral intervention are often derived from acceptance and commitment therapy (ACT) principles. ACT is a mindfulness-based psychotherapy modality that posits that attempts to willfully alter difficult thoughts, feelings, or sensations are often counter-productive [13, 14]. Instead, ACT emphasizes the importance of living with *psychological flexibility*. Psychological flexibility is the ability to be aware of, accept, and proceed with gentle persistence despite uncomfortable sensations, thoughts, and feelings that may accompany behaviors consistent with personal values. ACT holds that six core processes facilitate psychological flexibility (Table 1), and has been identified as a promising approach for addressing the unwanted internal experiences that may accompany psychological challenges stemming from cancer diagnosis [15, 16]. Emerging

evidence suggests that interventions centered on ACT processes, typically involving face-to-face instruction, may be effective for physical activity promotion to insufficiently active adults [17].

There has yet been limited research to investigate the use of electronically delivered acceptance- and mindfulness-based approaches to physical activity promotion for cancer survivors. It is unknown to what degree this approach to physical activity promotion would be perceived as relevant and appropriate by cancer survivors, and to what degree such content may be meaningfully administered electronically to this population. The aim of this study was to investigate the potential utility of an acceptance- and mindfulness-based physical activity intervention (the ACTive Program) in a sample of insufficiently active breast cancer survivors.

## Methods

### Intervention

This study was a non-randomized trial study design centered on obtaining qualitative data on a novel behavioral intervention. The behavioral target of the intervention was to gradually increase moderate-to-vigorous intensity aerobic physical activity and muscle-strengthening physical activity in insufficiently active breast cancer survivors with the goal of meeting the nationally recommended guidelines [18]. The ACTive Program was derived from ACT training experience, existing literature [13, 19], and the Mindful Steps manual (which codifies essential ACT concepts, metaphors, and exercises in the context of physical activity promotion for insufficiently active adults) [20]. The ACTive Program consisted of nine modules. Modules were sent weekly and included narrated videos with visual aids (e.g., didactic videos covering ACT processes), audio files (e.g., mindfulness exercises), images, text, and accompanying documents and email/text messages presenting techniques for ACT processes (see Table 1). Each module contained electronic workbook-type activities that encouraged participants to personally reflect on lesson content and apply the material to their own lives. All intervention content was delivered to participants electronically via secure REDCap (Research Electronic Data Capture) surveys.

### Recruitment

Inclusion criteria included being female; ever having had a diagnosis of breast cancer (any stage); having completed primary cancer treatment; and owning a smartphone or a computer with Internet access. Exclusion criteria included currently undergoing chemotherapy or radiation as primary cancer treatment; planning or preparing for surgery

**Table 1** Definitions of six core ACT psychological processes

ACT process	Definition <sup>a</sup>	Examples of how processes are targeted in the ACTive Program <sup>b</sup>
Values	“Values are chosen qualities of purposive action that can never be obtained as an object but can be instantiated moment by moment”	<i>The magic wand exercise</i> ; a dedicated didactic module (session 3) centered on this process with the compass metaphor; <i>the future birthday visualization</i> ; electronic workbook-type exercises with examples
Committed action	“The development of larger and larger patterns of effective action linked to chosen values”	A dedicated didactic module (session 4) with examples for deriving goals and committed actions from personally held values; electronic workbook-type exercises for goal setting and identifying committed actions with reminders of participants’ previously stated values; optional physical activity goal setting with positive reinforcement
Acceptance of internal experience	The active embrace of internal events without unnecessary attempts to change their frequency or form	Didactic videos for differentiating internal vs. external barriers to physical activity; <i>barriers in your backpack</i> visualization exercise; electronic workbook-type exercises to foster <i>creative hopelessness</i> regarding previous patterns for addressing internal barriers to physical activity; a dedicated didactic module (session 5) for acceptance of unhelpful internal events, including the <i>struggle switch</i> and <i>polygraph metaphors</i> ; acknowledging and normalizing that physical activity can and often does engender such events
Cognitive defusion	Attempts to change the way one interacts with or relates to thoughts by “creating contexts in which their unhelpful functions are diminished”	A dedicated didactic module (session 6) with content on the evolutionary reasons for suffering, the <i>Demons on a boat</i> metaphor, Titchener’s repetition exercise, and how to use cognitive defusion techniques to overcome unhelpful thoughts; electronic workbook-type exercises with examples for applying cognitive defusion to physical activity; <i>note card exercise</i> (physically putting distance between you and problematic thoughts)
Contact with the present moment	“Non-judgmental contact with psychological and environmental events as they occur”	Regular, guided mindfulness audio sessions to start all modules (e.g., <i>Leaves on a stream</i> exercise, mindful walking exercise); a dedicated didactic module (session 7) centered on this concept with an extended mindfulness exercise (the <i>watch your thinking</i> exercise)
Recognition of self as context	“Being aware of one’s own flow of experiences without attachment to them or an investment in which particular experiences occur”	The <i>notice who’s noticing</i> exercise; the <i>hexaflex</i> exercise

<sup>a</sup>See Hayes, 2004<sup>b</sup>See [13, 19] and Martin, 2015[20]

as primary treatment or as a reconstruction procedure in the next 3 months; reporting a modified Physical Activity Readiness Questionnaire (PAR-Q) score indicating that physical activity may not be safe, and engaging in  $\geq 150$  min/week of moderate-intensity aerobic exercise,  $\geq 75$  min/week of vigorous-intensity aerobic exercise, or an equivalent combination as measured by the Godin Leisure Time Exercise Questionnaire [21].

Participants were recruited via the Dr. Susan Love Research Foundation's Love Research Army®. This organization distributes recruitment material to a large electronic mailing list comprised of individuals in the USA who have indicated a general interest in receiving information about opportunities to participate in breast cancer-related research. Additional participants were similarly recruited via email from support groups and previous studies at the University of Texas MD Anderson Cancer Center.

### Individual interviews

MR conducted semi-structured individual interviews with participating breast cancer survivors after they completed the intervention. Interviews took place between April and September 2020. The interviews were conducted via telephone with the assistance of an interview guide and were between 30–60 min in length. All interviews were audio recorded and professionally transcribed verbatim.

### Qualitative data analysis

Three coders (MR [a graduate student with training in health promotion and behavioral science-related research], YL [a university faculty member with training in health promotion and behavioral science-related research], and SF [an undergrad with work experience in health promotion and behavioral science-related research]) conducted template analysis on interview transcripts [22, 23]. Template analysis is a type of thematic analysis that combines flexible, directed hierarchical coding with a relatively high degree of structure. Each coder independently assigned codes to discrete points made by interviewees. These codes were both deductive (derived from the semi-structured interview guide) and inductive in nature (unanticipated themes that emerged during discussion). The coders synthesized all data into an analytical template which outlined major themes and subthemes [22, 23]. The coding team met regularly throughout the course of conducting the analysis to engage in consensus-building for code assignment and to continuously refine the codebook, themes, and subthemes, relationships between the codes, and our notions of the overarching structure of study data. Qualitative data analysis was performed using Dedoose qualitative data analysis software (Version 8.3.35, Los Angeles, CA).

**Table 2** Participant characteristics ( $N=16$ )

Characteristic	Category	<i>n</i> (%)
Education level	HS diploma/GED	0 (0)
	Some college	8 (50.0)
	Bachelor's degree	3 (18.8)
	Graduate school degree	5 (31.2)
Employment status	Employed full time	6 (42.9)
	Employed part time	2 (14.3)
	Retired	6 (42.9)
Marital status	Single	3 (18.8)
	Married	9 (56.2)
	Living with significant other	1 (6.2)
	Divorced	2 (12.5)
	Widowed	1 (6.2)
Race	American Indian, Alaska native, or other	1 (6.2)
	Asian	1 (6.2)
	Black/African American	1 (6.2)
	White	13 (81.2)
Ethnicity	Hispanic	1 (6.2)
	Non-Hispanic	15 (93.8)
Stage at diagnosis of breast cancer	1	5 (31.2)
	2	6 (37.5)
	3	3 (18.8)
	4	2 (12.5)
BMI status	Normal	7 (46.7)
	Overweight	3 (20.0)
	Obese	5 (33.3)

## Results

### Participant characteristics

This study took place in the context of sweeping “Stay-at-Home” orders enacted by state governments in March and April to curb the spread of COVID-19. We recruited 30 participants. In total, 28 participants completed the baseline survey and received the ACTive Program content. Of those, 16 engaged in an in-depth individual interview. The mean age of the final sample was 58.4 years ( $SD=13.8$ , range 28–82) and the median time since breast cancer diagnosis was 5 years (interquartile range, 4–9). The sample was relatively well educated (50.0% college graduates), mostly non-Hispanic white (77.8%), and mostly overweight

or obese (58.8%, Table 2). We did not observe a statistically significant difference between those who completed the study and those who did not in time since breast cancer diagnosis or any of the participant characteristics presented in Table 2 (all  $p > = 0.250$ ). There was a trend such that those who withdrew or were lost to follow-up tended to be younger than those who were not lost to follow-up ( $W = 48.5$ ,  $p$ -value = 0.100).

## Themes

We identified two overarching themes pertaining to the relevance and potential utility of electronically delivered acceptance- and mindfulness-based approaches to physical activity promotion in insufficiently active breast cancer survivors. These were (1) barriers to physical activity adherence and (2) utility of acceptance- and mindfulness-based principles and processes for physical activity promotion.

### Barriers to physical activity adherence

Participants discussed numerous barriers to living a physically active lifestyle and reported facing marked challenges due to cancer treatment and diagnosis. For some of these barriers, like uncertainty about how to rehabilitate injuries or how to safely engage in physical activity with lymphedema, participants expressed a need for direct, instrumental support. Related, participants perceived there to be a gap in guidance for how they might transition to living a physically active lifestyle after the completion of their primary treatment. One participant said:

I had a double mastectomy and the DIEP flap reconstruction and there's very little out there that shows me, okay, how do I regain my arm strength... for the mastectomy or in even people who have lumpectomies, I think there's a loss in the chest area that we've looked to fulfill and maybe something geared towards that might help. [ACT021, age 47]

Participant identified other barriers, however, for which actionable solutions were not forthcoming. These included anxiety, depressive symptoms, fatigue, lack of motivation for physical activity, lack of finding physical activity enjoyable (including finding it boring and/or physically unpleasant), and having other responsibilities that took precedence (e.g., family caregiving responsibilities). When asked about what gets in the way of exercising, one participant shared:

I think sometimes when the hind brain gets in and it's like, 'It doesn't matter', when you start feeling down and whatever else, you just want to be slightly depressed and curl up and not do anything at all. [ACT054, age 54]

### Acceptance- and mindfulness-based principles and processes for physical activity promotion

Participants indicated that they valued their experience with ACTIVE Program content and that they thought its approach to physical activity promotion intervention would be useful for breast cancer survivors generally. They reported that they found the featured content and techniques to be inherently interesting, unique, and empowering. We present sub-themes that correspond to the ACT principles of acceptance and defusion, mindfulness, and values and goal setting.

### Acceptance and defusion

The acceptance- and defusion-based processes struck a particularly resonant chord. One participant said:

...it was a different way of framing [exercise] like, 'Okay, yeah, it hurts, or you're tired or you don't want to do it, or you're lazy. You'd rather play a game or something...that's what you're feeling... You don't have to fix it.' You just have to acknowledge it and then say, 'I'm going to do it [exercise] anyway. [ACT054, age 54]

Acceptance was often discussed in terms of challenges linked to physical activity, such as guilt associated with not being sufficiently active or dissatisfaction about current states/abilities. In this context, many participants reported that the program's invitation to have the user regard her status with acceptance, rather than as an outstanding problem, was deeply empowering. One participant stated:

And the words though about be kind to yourself, this is your journey, be gentle and kind. Wow. I never saw it in writing to give myself permission to be gentle and kind to myself. I mean, as old as I am, you think, 'Do it, get the house clean. Do this.' and just be hard on yourself and be your own sergeant, like a drill sergeant. And I thought, 'Well, that's not really working. Let's try this. Let's try the gentle and kind, like you would treat a highly-prized friend.' You wouldn't be, 'Go clean your kitchen, get the bathroom clean.' No, you don't talk to other people like to yourself, so why would you talk to yourself like that? So it changed me, it really did. [ACT055, age 62]

The ACTIVE program content featured many commonly used ACT metaphors. Participants highlighted some of these as being especially useful, and some as needing revisions for appropriateness in a survivorship context (Table 3).

**Table 3** Comments on specific ACT devices applied to physical activity promotion for insufficiently active breast cancer survivors

ACT construct	ACT device <sup>a</sup>	Participant quote
Values	100th birthday visualization	“It’s not a big sore point, but I think there are very few cancer survivors who think they’re going to live to 100.” [ACT041, age 70]
Acceptance	Barriers in the backpack	The backpack visualization is tremendously helpful. [ACT021, age 47] The backpack activity is a good way to keep moving. I look forward to using that strategy. [ACT039, age 65]
	Chessboard metaphor	I didn’t particularly like the analogy of positive and negative feelings depicted by the white and black chess pieces. [A breast cancer survivor member of the expert panel]
Defusion	Demons in a boat metaphor	I can’t even remember the details, but it’s stuck in my mind, it’s something that stuck in my mind, about trying to navigate to the shore and going against the wind and all those kinds of things...that was the one that was truly new to me and I’m like, ‘Whoa. Yeah, okay. Thank you.’ [ACT054, age 54]
	Notecard defusion exercise	The one where you put your technique on a little piece of paper and carry it with you. That worked like magic for me. It was just magic. I don’t know why; it just unlocked something in me. And I refer to that little paper a lot, and so it got all crumple-y and it was worn out. It was like a little secret boost that I could give my attitude. And it was just a wonderful technique for me to distance, or it kind of shut down the adrenaline and give myself some distance between what am I thinking, and what is really happening, and ‘is it really that bad?’ And it just kind of made me have inner calm. [ACT055, age 62]
	The question used to foster defusion from thoughts: “it may be true, but is it helpful?”	And the third idea that I found helpful was, and again, this relates to negative thoughts or roadblocks that you might come across the idea of when something flutters into your mind the idea of, ‘is it helpful? Is this idea that is currently bouncing around in your head, is it helpful? Is it a helpful thought? Is it helpful idea?’ And if it’s not, just let it go.” [ACT041, age 70]
Mindfulness	Leaves on a stream	“And the thing that sticks with me most of all is if I can find that thought, put it on a leaf and watch it float away.” [ACT042, age 82]

### Contact with the present moment

While most participants’ initial motivation to participate in the study was to increase physical activity (and/or to help others), participants communicated that the mindfulness aspect of the program turned out to be a highly valued feature.

...it was exactly what I needed, every part of it. And I think especially the parts where there was actually time in there for a mini-meditation or a mindfulness section where we sat quietly and you guided it, it was amazing for me. That kind of thing really changes my thought processes and the way my brain works, apparently. So that was really important for me and I never really thought about adding the mindfulness to my walking, that’s what I’m trying to start out with is walking and adding that and living in the moment is huge, it changes everything. [ACT018, age 55]

For some participants, mindfulness practices imbued bouts of physical activity with a sense of enjoyment:

So I can go out and walk, but when I’m more mindful, I just seem to get more out of it. I was just doing it like a chore before, when I did walk and think about my

grocery list for Kroger and all that. And now I think, ‘I’m holding my head up. I’m enjoying scenery, I’m relaxing. My adrenal stress hormones are subsiding. I’m zenning it, man. [ACT055, age 62]

One participant, who shared that she felt the program overall was not a great fit for her, said that she valued the ability to use mindfulness to appreciate the larger context in which the physical activity was occurring. She shared:

...even though here I am putting myself through 20 of this and 20 of that [exercises], 20 of this kind of stretches 20 of that kind of leg lift, 20 of... Though I’m putting myself through this rather boring and sometimes difficult routine, everything else is okay. Everything else is just fine. I’m in a room where I like the light, I’m in a room where I like the color of the walls, I can hear the sounds of my neighborhood. It kind of helps in that it puts more of a positive spin on it, so it’s less distracting and it is adding a positive spin. [ACT041, age 70]

While the mindfulness exercises were enjoyed by many, some did not find them especially useful. While some participants shared that they appreciated that the program instruction normalized lapses in concentration, frustrations

pertaining to difficulty concentrating emerged as an impediment to enjoying this aspect of program content (along with finding the time to engage in mindfulness exercises). One participant, who enjoyed many aspects of the program, shared:

I wasn't a big fan of the recordings for, sit back in a chair, the meditation portions of it. I have a hard time finding quiet time that I could actually spend and pay attention to the entire part. [ACT047, age 39]

## Values and goal setting

The ACTive Program was designed to have participants connect the numerous benefits of living a physically active lifestyle to their personally held values and set at least one physical activity-related goal. Some participants found this to be a useful exercise. One participant stated:

I loved how you continually reminded us of our goals and our values. This may be somewhat of a stretch, but if I'm healthy, then my family can be healthy. So no, no, it's not a stretch at all... It's sets your mind of being kind to yourself as a patient, and you're allowed these times, you're allow these moments, you need this time, you need this moment... I'm not taking away from anybody else, I'm actually giving to people. If I'm strong and healthy, then I'm actually giving more to them than if I'm feeling miserable, depressed. [ACT050, age 42]

However, having participants establish a meaningful link between their own personal values and physical activity behaviors generally emerged as a challenge.

I can't remember what I put out for values, but there didn't seem always to be to me a direct link to physical activity... I mean, knowing that increased physical activity is going to make me feel better, it's a positive and it is going to help me accomplish other things that I want to do, but it's just hard to connect them directly, I guess. [ACT040, age 73]

## Discussion

The aim of this study was to characterize the relevance and potential utility of acceptance- and mindfulness-based techniques for physical activity promotion with insufficiently active breast cancer survivors. Our results indicated that this approach addressed important needs related to physical activity and related cognitions in this population. We identified two overarching themes from in-depth interviews. These pertained to barriers to physical activity, and the relevance

and potential utility of using ACT processes for physical activity promotion.

Our findings are concordant with previous literature that has identified fatigue, pain, physical limitation, and decreased physical functioning as common challenges to physical activity faced by breast cancer survivors [9–12]. In the present study, some participants reported experiencing a precipitous drop in guidance and support after completion of primary treatment. Participants were often uncertain how to transition into healthy lifestyle behaviors after completion of primary treatment, and how to remedy decreases in physical functioning caused by cancer treatment. Participants reported not finding physical activity intrinsically rewarding, and that they sometimes experienced negative psychological symptoms linked to their cancer that could interfere with their motivation and ability to engage in physical activity.

Our findings also support emerging evidence that indicates that physical activity interventions derived from ACT principles may hold promise [17, 24]. The aim of the intervention developed in the present study was to target ACT processes in the context of living an active lifestyle, and many participants reported that the intervention helped to reframe unpleasant internal experiences linked to physical activity and/or imbued exercise routines with a sense of enjoyment. Intervention content centered on acceptance, defusion, and mindfulness was particularly well received; it was perceived to be useful and empowering, and in some cases occasioned meaningful insights in participants. Further, our findings suggest that acceptance- and mindfulness-based physical activity interventions may be delivered effectively online. This finding comports with evidence suggesting that this population is generally receptive to digital behavioral interventions [25], particularly those that can be accessed via computer [26]. This suggests that the principles and techniques that have garnered considerable success in the realm of psychotherapy may be able to be applied effectively to physical activity promotion and other public health priorities.

One challenge encountered in the present study was the process of leveraging participants' personally held values for increasing motivation for healthy lifestyle behavior change. While this enterprise was useful to some, to others the link was less clear. Interviews revealed that in some cases participants' prior associations with the term *values* may have provided some interference with how the construct was operationalized in the present study (e.g., the term *values* was sometimes thought to implicate moral and social imperatives that are inculcated by one's upbringing, rather than freely chosen guiding principles that motivate ongoing actions). It may be that alternate diction (e.g., *chosen life directions* [19]) and other refinements of the electronic workbook-type activities could lead to greater success. More research is needed to investigate how to facilitate the process

of meaningful connections between personally held values and healthy lifestyle behavior changes in the context of scalable interventions.

## Study limitations

The findings of this study must be considered in the context of its limitations. The generalizability of this study is limited by its convenience sampling method. The sample recruited was mostly non-Hispanic White and relatively well educated. While we recruited participants who did not meet recommended physical activity guidelines, it may have been that the sample was particularly motivated to increase their physical activity. Further, we recruited participants via electronic means, so they may have tended to be especially receptive to an electronically delivered intervention. The COVID-19 pandemic precluded the use of some recruitment strategies that may have yielded a more diverse sample, but future studies should investigate to what degree findings hold true for more diverse populations. This investigation is further limited by the fact that the principal investigator recruited participants initially, delivered much of the intervention content, and conducted the in-person interviews; although in each interview we made a point of encouraging candid, critical feedback, our results may have been affected by social desirability bias. Another challenge encountered in the present study was a high attrition rate. In the present study, only 60% of those recruited completed the follow-up survey. The high attrition rate may have been impacted by the COVID-19 pandemic; sweeping stay-at-home orders were implemented during the time the first cohort of participants were participating in the study, and the COVID-19 pandemic has impacted individuals' mental health and ability and desire to participate in research studies [27]. Most participants who were lost to follow-up did not provide information as to why they ceased participating, but the only person who explicitly withdrew from the study indicated that she was no longer able to participate due to having to homeschool her children because of schools closing. Despite the high attrition, it is noteworthy that the study was able to continue without major changes to procedures during these calamitous circumstances. While the pandemic may have altered participants' physical activity patterns and mental health, participants indicated that the study content was especially timely and helpful.

## Conclusions

In conclusion, electronically delivered physical activity interventions based on ACT principles offer promise for insufficiently active breast cancer survivors. This approach

may be well received and can address important needs related to healthy living. Given the sometimes private, internal nature of lingering challenges to physical activity that can follow cancer diagnosis and treatment, targeting ACT processes may be especially useful for promoting physical activity in cancer survivors. Future research is needed to expand this research to more diverse populations, refine the digital delivery of ACT-derived intervention content (e.g., for values clarification), and evaluate the efficacy of this approach for impacting physical activity behaviors and their psychosocial determinants.

**Acknowledgements** This study was supported by the Center for Energy Balance in Cancer Prevention and Survivorship. Participant recruitment was facilitated by Dr. Susan Love Research Foundation's Love Research Army®.

**Author contribution** M.R. conceived the project, developed the behavioral intervention, and wrote the manuscript with support from E.C.M., R.S., C.M., K.F., C.P.D., A.B., E.J.L., and K.B.E. M.R., Y.L., and S.A.F. conducted the qualitative analysis. All authors approved of the final version of this paper.

**Funding** Michael Robertson was supported by the National Cancer Institute of the National Institutes of Health (F31 CA236433). This study used MD Anderson's Assessment, Intervention, and Measurement (AIM) Core, a shared resource supported by the National Institutes of Health through MD Anderson's Cancer Center Support Grant (P30 CA016672). The content of this paper is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

**Data availability** The data that support the findings of this study are available from the corresponding author, MCR, upon reasonable request.

**Code availability** Not applicable.

## Declarations

**Ethics approval** This project was approved by the University of Texas School of Public Health at Houston's Committee for the Protection of Human Subjects (HSC-SPH-18-1025).

**Consent to participate** Verbal informed consent was obtained from all participants.

**Consent for publication** Not applicable.

**Conflict of interest** The authors declare no competing interests.

## References

1. Schmitz KH et al (2019) Exercise is medicine in oncology: engaging clinicians to help patients move through cancer. *CA Cancer J Clin* 69(6):468–484
2. Campbell KL et al (2019) Exercise guidelines for cancer survivors: consensus statement from international multidisciplinary



- roundtable. *Med Sci Sports Exerc* 51, no. 11, Art. no. 11. <https://doi.org/10.1249/MSS.0000000000002116>
3. Patel AV et al (2019) American college of sports medicine roundtable report on physical activity, sedentary behavior, and cancer prevention and control. *Med Sci Sports Exerc* 51, no. 11, Art. no. 11. <https://doi.org/10.1249/MSS.0000000000002117>
  4. Blanchard CM, Courneya KS, Stein K, American Cancer Society's SCS-II (2008) Cancer survivors' adherence to lifestyle behavior recommendations and associations with health-related quality of life: results from the American Cancer Society's SCS-II. *J Clin Oncol Off J Am Soc Clin Oncol* 26(13):2198–2204. <https://doi.org/10.1200/JCO.2007.14.6217>
  5. Sheeran P et al (2019) Promoting physical activity among cancer survivors: meta-analysis and meta-CART analysis of randomized controlled trials. *Health Psychol* 38(6):467
  6. Abdin S, Lavallée JF, Faulkner J, Husted M (2019) A systematic review of the effectiveness of physical activity interventions in adults with breast cancer by physical activity type and mode of participation. *Psychooncology* 28(7):1381–1393
  7. Michie S, Abraham C, Whittington C, McAteer J, Gupta S (2009) Effective techniques in healthy eating and physical activity interventions: a meta-regression. *Health Psychol* 28(6):690–701. <https://doi.org/10.1037/a0016136>
  8. Michie S, Richardson M, Johnston M, Abraham C, Francis J, Hardeman W, Eccles MP, Cane J, Wood CE (2013) The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions. *Ann Behav Med* 46(1):81–95. <https://doi.org/10.1007/s12160-013-9486-6>
  9. Milne HM, Guilfoyle A, Gordon S, Wallman KE, Courneya KS (2007) Personal accounts of exercise and quality of life from the perspective of breast cancer survivors. *Qual Life Res* 16(9):1473–1481. <https://doi.org/10.1007/s11136-007-9251-z>
  10. Smith-Turchyn J, Richardson J, Tozer R, McNeely M, Thabane L (2016) Physical activity and breast cancer: A qualitative study on the barriers to and facilitators of exercise promotion from the perspective of health care professionals. *Physiother Can* 68(4):383–390. <https://doi.org/10.3138/ptc.2015-84>
  11. Smith L, Croker H, Fisher A, Williams K, Wardle J, Beeken RJ (2017) Cancer survivors' attitudes towards and knowledge of physical activity, sources of information, and barriers and facilitators of engagement: A qualitative study. *Eur J Cancer Care (Engl)* 26(4). <https://doi.org/10.1111/ecc.12641>
  12. Cummins C, Kayes NM, Reeve J, Smith G, MacLeod R, McPherson KM (2017) Navigating physical activity engagement following a diagnosis of cancer: A qualitative exploration. *Eur J Cancer Care (Engl)* 26(4). <https://doi.org/10.1111/ecc.12608>
  13. Hayes SC (2004) Acceptance and commitment therapy, relational frame theory, and the third wave of behavioral and cognitive therapies. *Behav Ther* 35(4):639–665
  14. Hayes SC, Luoma JB, Bond FW, Masuda A, Lillis J (2006) Acceptance and commitment therapy: model, processes and outcomes. *Behav Res Ther* 44(1):1–25
  15. Hulbert-Williams NJ, Storey L, Wilson KG (2015) Psychological interventions for patients with cancer: psychological flexibility and the potential utility of Acceptance and Commitment Therapy. *Eur J Cancer Care (Engl)* 24(1):15–27. <https://doi.org/10.1111/ecc.12223>
  16. Mosher CE et al (2018) Acceptance and commitment therapy for symptom interference in metastatic breast cancer patients: a pilot randomized trial. *Support Care Cancer* 26(6):1993–2004
  17. Pears S, Sutton S (2020) Effectiveness of acceptance and commitment therapy (ACT) interventions for promoting physical activity: a systematic review and meta-analysis. *Health Psychol Rev*: 1–26. <https://doi.org/10.1080/17437199.2020.1727759>
  18. Kushi LH et al (2012) American Cancer Society Guidelines on nutrition and physical activity for cancer prevention: reducing the risk of cancer with healthy food choices and physical activity. *CA Cancer J Clin* 62(1):30–67
  19. Harris R (2019) ACT made simple: an easy-to-read primer on acceptance and commitment therapy. New Harbinger Publications, Oakland
  20. Martin EC, Galloway-Williams N, Cox MG, Winett RA (2015) Pilot testing of a mindfulness-and acceptance-based intervention for increasing cardiorespiratory fitness in sedentary adults: a feasibility study. *J Context Behav Sci* 4(4), Art. no. 4
  21. Godin G, Shephard RJ (1985) A simple method to assess exercise behavior in the community. *Can J Appl Sport Sci* 10(3):141–146
  22. Brooks J, McCluskey S, Turley E, King N (2015) The utility of template analysis in qualitative psychology research. *Qual Res Psychol* 12(2):202–222
  23. King N (1998) Template analysis. In Symon G, Cassell C (eds) *Qualitative methods and analysis in organizational research: A practical guide*. Sage Publications Ltd., pp 118–134
  24. Zimmermann FF, Burrell B, Jordan J (2018) The acceptability and potential benefits of mindfulness-based interventions in improving psychological well-being for adults with advanced cancer: A systematic review. *Complement Ther Clin Pract* 30:68–78. <https://doi.org/10.1016/j.ctcp.2017.12.014>
  25. Haberlin C, O'Dwyer T, Mockler D, Moran J, O'Donnell DM, Broderick J (2018) The use of eHealth to promote physical activity in cancer survivors: a systematic review. *Support Care Cancer* 26(10):3323–3336. <https://doi.org/10.1007/s00520-018-4305-z>
  26. Martin EC et al (2016) Interest in health behavior intervention delivery modalities among cancer survivors: a cross-sectional study. *JMIR Cancer* 2(1):e1
  27. Cardel MI, Manasse S, Krukowski RA, Ross K, Shakour R, Miller DR, Lemas DJ, Hong YR (2020) COVID-19 impacts mental health outcomes and ability/desire to participate in research among current research participants. *Obesity (Silver Spring)* 28(12):2272–2281. <https://doi.org/10.1002/oby.23016>

**Publisher's note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.