




# Breast cancer survivors' perspectives on a home-based physical activity intervention utilizing wearable technology

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## Abstract

**Purpose** To gain breast cancer survivors' perspectives on participation in a home-based physical activity intervention and the factors that contributed to their acceptance and adherence to physical activity.

**Methods** Semi-structured interviews were conducted with six women who had participated in a 12-week, home-based physical activity intervention using Polar A360® activity trackers. Additionally, 22 participants from the physical activity interventions provided scaled responses to barriers of physical activity on weeks 3, 6, 9, and 12. Interviews were transcribed verbatim. Thematic analysis was used for qualitative data.

**Results** Perceptions ( $n = 6$ ) were categorized into three main themes including (i) *Study Environment* which consisted of three subthemes *acrch versus fear of failure*, *power of results*, and *reminders of cancer and moving beyond*. (ii) *Influence of People* encompassed two subthemes, i.e., *personal relationships* and *self as a source of motivation*; and (iii) *Wearable Technology* which was divided into two subthemes, i.e., *objective insights into health* and *disconnect of person and technology*. From the scaled responses, the most impactful barriers for participants within the intervention groups ( $n = 22$ ) were “feeling busy,” “lack of motivation,” and “weather.”

**Conclusion** Wearable technology was perceived largely as a facilitator to physical activity in the current study, but technologic difficulties created a barrier to physical activity adherence. Additionally, participants' perceptions of study design elements and social support influenced their acceptance and adherence to the home-based physical activity interventions and should be considered to inform the design and implementation of future studies.

**Keywords** Breast cancer survivorship · Motivation · Facilitators · Barriers · Activity trackers

## Introduction

One in eight women living in Canada are expected to develop breast cancer in their lifetime [1]. By 2017, the 5-year survival rate was 87% as a result of screening and improved treatments

[1]. However, negative psychosocial and physical side effects such as cognitive impairment, depression, cancer-related fatigue, muscle aches, and sleep difficulties commonly occur after diagnosis and treatment [2]. Physical activity can help reduce these cancer-related side effects and increase physical function and fitness [2]. Yet, less than 15% of breast cancer survivors are meeting physical activity guidelines (150 min/week of moderate-vigorous physical activity) [3]. These findings are alarming given recent evidence suggesting that breast cancer survivors with the greatest post-diagnosis recreational physical activity levels have a reduced risk of recurrence and breast cancer-related death compared to survivors with the lowest physical activity levels [4].

Although the benefits of physical activity interventions based in recreational facilities are well established, breast cancer survivors have reported both cancer-specific limitations and situational barriers such as geographic proximity to recreational facilities, time of classes, or having other commitments

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as limiting their adherence to such interventions [5, 6]. Overcoming and understanding these barriers are central to improving physical activity levels in this population.

Wearable technology such as activity trackers have been adopted within many research settings to help participants self-assess their progress in achieving prescribed physical activity goals [7]. Wearable technology is a popular intervention tool because these devices allow participants and researchers to monitor physical activity participation continuously thereby reducing the need for costly equipment, facilities, personnel, and travel time associated with on-site interventions. An assessment of breast cancer survivors' preferences for technology-supported physical activity interventions reported that the majority (80–85%) were interested in receiving exercise counseling and an intervention delivered remotely [8]. Furthermore, almost 90% of participants agreed that an activity tracker would be the most helpful intervention component, even ahead of personalized feedback [8].

Previous studies examining breast cancer survivors' preferences for wearable technology have been conducted in absence of a physical activity intervention and for relatively short time periods (e.g., 2 weeks) [8, 9]. The Breast Cancer and Physical Activity Level (BC-PAL) pilot trial assessed the feasibility of a home-based intervention utilizing activity trackers to prescribe lower (300 min/week at 40–60% of heart rate reserve) or higher (150 min/week at 60–80% of heart rate reserve) intensity physical activity compared to no physical activity intervention (controls) in breast cancer survivors. The aim of the current study was to investigate breast cancer survivors' perspectives on their experiences participating in BC-PAL and the factors that contributed to their acceptance and adherence to physical activity.

## Methods

### Setting and participants

The current study was conducted as a *post hoc* component of the BC-PAL randomized controlled pilot trial. A full description of the methods and design for BC-PAL is provided elsewhere (McNeil J, Brenner DR, Stone CR, O'Reilly R, Ruan Y, Vallance JK, Courneya KS, Thorpe KE, Klein DJ, Friedenreich CM, 2018, Results from a home-based trial using activity trackers to prescribe different physical activity intensities in breast cancer survivors, unpublished). Briefly, participants were contacted by mail through the Alberta Cancer Registry and invited to contact the study team. Forty-five women met the inclusion criteria of: 18–75 years of age, a histologically confirmed stages I–IIIc breast cancer diagnosis, physically inactive (< 10,000 steps/day and < 60 min of moderate-vigorous intensity physical activity /week), completed all adjuvant treatment except for hormonal therapy, and a resident of Calgary, Canada. BC-PAL was a three-armed, 12-week randomized controlled trial, with participants randomized to either 300 min/week of

lower intensity physical activity (40–60% of heart rate reserve), 150 min/week of higher intensity physical activity (60–80% of heart rate reserve), or no physical activity (control) group. Participants within the intervention arms were given a pink wrist-worn Polar A360® activity tracker to monitor physical activity. Outcome assessments were conducted onsite at baseline, end of study (12 weeks), and follow-up (24 weeks). Participant check-ins occurred at the end of weeks 3, 6, and 9 via telephone, e-mail or in-person based on participant preference. This study was conducted according to the guidelines laid down in the 1964 Declaration of Helsinki; ethical approval was obtained from the Health Research Ethics Board of Alberta–Cancer Committee (HREBA.CC-16-0711). Participants provided written informed consent.

### Procedures

Multiple methods were used to gain insight into breast cancer survivors' perceptions of this study. First, participants within the two physical activity intervention groups were given diaries as an intervention tool and reported barriers to physical activity at the end of weeks 3, 6, 9, and 12. These diaries were based on questionnaires used in our previous physical activity trials [10] and asked on a scale of 1 (*no impact*) to 10 (*high impact*) how they felt the following barriers impacted their adherence to the physical activity goals: feeling busy, have no one to exercise with, lack of knowledge, weather, lack of motivation, and lack of interest. Second, we used a qualitative approach, conducted within a critical realism paradigm. Critical realism acknowledges both the ways individuals create meaning from their experiences and how the larger social context shapes those meanings [11]. It suggests that a version of reality exists that is not dependent on human perception while providing a framework to examine contextual dependent outcomes [12]. Following the intervention, we randomly sampled two participants from each of the three trial arms to obtain perspectives from participants across all trial conditions, while maintaining a sample size small enough to facilitate in-depth analysis of their experiences [13]. Random sampling continued until two participants from each group agreed to participate. Interviews were conducted in private with CS and an additional study team member (ML, JM, KK) who took field notes. Interviews focused on the participants' experiences and perspectives related to recruitment into the trial, experiences within the study, and barriers and facilitators to participating in the intervention (Table 1). Interviews lasted 22–101 min and were audio recorded.

### Data analysis

Descriptive statistics (median  $\pm$  interquartile ranges) were derived from the diaries and analyzed using STATA version 15 [14]. Thematic analysis was conducted with the qualitative data

**Table 1** Semi-structured interview guide used in the BC-PAL pilot trial

Semi-structured interview guide
1.1 How did you find out about the study?
1.2 What do you think are the best ways to recruit breast cancer survivors for our study?
1.3 What incentives do you think would motivate someone to enroll in the study?
1.4 Why do you think an eligible participant might choose to not partake in the BC-PAL study?
1.5 Did you consider not participating in the study?
2.1 What was the most enjoyable part of the study for you?
2.2 What parts of the study did you find beneficial? What was the most beneficial? Why?
2.3 How valuable was it for you to receive your results from our testing?
3.1 Can you describe some of the challenges you experienced while taking part in the study?
3.2 What did you do to maintain your motivation to continue with the study?
3.3 What was your biggest source of support for completing your goals?
3.4 Were the three week check-ins beneficial/enough?
3.5 How did you find the time commitment for the study?
3.6 What strategies did you use to find time to complete the intervention? How can we help?
3.7 How can we help you maintain interest in the study and your goals?

[11]. Interviews were transcribed verbatim and checked for completeness by a second member of the study team (AF, RK-P, BV). Participants' names were replaced with pseudonyms and identifying characteristics (e.g., names of family members, hospitals, other locations) were removed during transcription. Transcripts were read to get a sense of the whole and similar underlying ideas were given the same code. Coding of the entire data set was performed independently by AF and RK-P using NVivo11 (QSR International) [15]. Codes describing similar ideas were grouped as themes which were reviewed to ensure that they were distinct and internally coherent. Themes were named and defined, and key quotes were selected to illustrate the findings within each theme. The study team consulted about coding and analysis decisions, and differences in perspectives were resolved via discussion. The lived experiences of the authors and the health care setting of this work contributed to the identification of themes within this analysis. The study team was comprised of female researchers focused on modifiable risk factors for cancer prevention from disciplines of kinesiology and epidemiology. Experience working with breast cancer survivors ranged from 1 to 25 years and all members have a history of physical activity involvement.

## Results

### Participants

The study participants ( $n = 6$ ) were, on average, 58 years of age with an even distribution of previous stage I to

IIIc breast cancer and had completed their treatments 2.5 years before the interview (Table 2). They were mainly Caucasian, had completed post-secondary education, and had a relatively high household income. The participants included in the interview component of this trial were representative of the overall participants from BC-PAL. The participants who completed the semi-structured interviews also had similar characteristics compared to those who were approached but refused to complete the semi-structured interviews (results not shown).

The results of the BC-PAL trial have been reported elsewhere (McNeil J, Brenner DR, Stone CR, O'Reilly R, Ruan Y, Vallance JK, Courneya KS, Thorpe KE, Klein DJ, Friedenreich CM, 2018, Results from a home-based trial using activity trackers to prescribe different physical activity intensities in breast cancer survivors, unpublished). Briefly, both physical activity groups had an increase in cardiopulmonary fitness/ $VO_{2max}$  at 12 weeks, which were significantly greater than changes in  $VO_{2max}$  in the control group (lower intensity physical activity group least squares adjusted group difference (LSAGD) = 4.2 (95% confidence interval (CI) = 0.5, 8.0 ml/kg/min); higher intensity physical activity group LSAGD = 5.4 (95% CI = 1.7, 9.1 ml/kg/min)). Data from the Polar A360® activity trackers also indicated that participants in the lower intensity physical activity group averaged  $921 \pm 416$  min/week within the prescribed heart rate zone of 40–60% of heart rate reserve and this group displaced ~60 min/day of sedentary time to total physical activity. Participants in the higher intensity physical activity group averaged  $147 \pm 89$  min/week within the prescribed heart rate zone of 60–80% of heart rate reserve and had a mean increase in total physical activity of ~40 min/day with very little change in sedentary time at 12 weeks compared to baseline. Lastly, there were no intervention-related side effects of physical activity reported by participants throughout the study.

### Barriers to physical activity reported in diaries

Feeling busy was the most impactful barrier followed by lack of motivation and weather (Fig. 1). Lack of interest, lack of knowledge, and having no one to exercise with were consistently reported as having “no impact” for all time points (data not shown).

### Experiences with the BC-PAL trial from semi-structured interviews

#### Study environment

#### Accountability to participate in research versus fear of failure

The study environment provided motivation to participate in research through feelings of accountability. This topic was

**Table 2** Baseline participant characteristics for those who completed the semi-structured interviews, the diaries, and the pilot trial. The Breast Cancer and Physical Activity Level (BC-PAL) pilot trial, Calgary, Alberta, Canada, 2017–2018

Characteristics	Interview ( <i>n</i> = 6)	Diary ( <i>n</i> = 22)*	BC-PAL pilot trial ( <i>n</i> = 45)
Age (years); mean ± SD	58 ± 7	58 ± 10	58 ± 9
Time since treatment (days) mean ± SD	923 ± 412	1022 ± 550	1181 ± 925
Cancer stage at diagnosis			
Stage I; <i>n</i> (%)	2 (33.3)	6 (27.3)	17 (37.8)
Stage II; <i>n</i> (%)	2 (33.3)	13 (59.1)	20 (44.4)
Stage III; <i>n</i> (%)	2 (33.3)	3 (13.6)	8 (17.8)
Cancer treatments received			
Surgery; <i>n</i> (%)	6 (100)	22 (100)	45 (100)
Chemotherapy; <i>n</i> (%)	6 (100)	19 (86.4)	36 (80.0)
Radiation treatment; <i>n</i> (%)	4 (66.7)	18 (81.8)	36 (80.0)
Hormonal therapy; <i>n</i> (%)	3 (50.0)	17 (77.3)	36 (80.0)
Marital status			
Married or common law; <i>n</i> (%)	4 (66.7)	17 (77.3)	35 (77.8)
Other; <i>n</i> (%)	2 (33.3)	5 (22.7)	10 (22.2)
Education			
≤ High school; <i>n</i> (%)	1 (16.7)	5 (22.7)	8 (17.8)
≥ Post-secondary school; <i>n</i> (%)	5 (83.3)	17 (77.3)	37 (82.2)
Ethnicity			
Caucasian; <i>n</i> (%)	6 (100)	20 (90.9)	36 (80.0)
Other; <i>n</i> (%)	0 (0)	2 (9.1)	9 (20.0)
Total household income			
< \$50,000; <i>n</i> (%)	1 (16.7)	0 (0)	4 (8.9)
\$50,000–100,000; <i>n</i> (%)	3 (50.0)	10 (45.5)	19 (42.2)
> \$100,000; <i>n</i> (%)	1 (16.7)	11 (50.0)	16 (35.6)
Prefer not to disclose or I do not know; <i>n</i> (%)	1 (16.7)	1 (4.5)	6 (13.3)

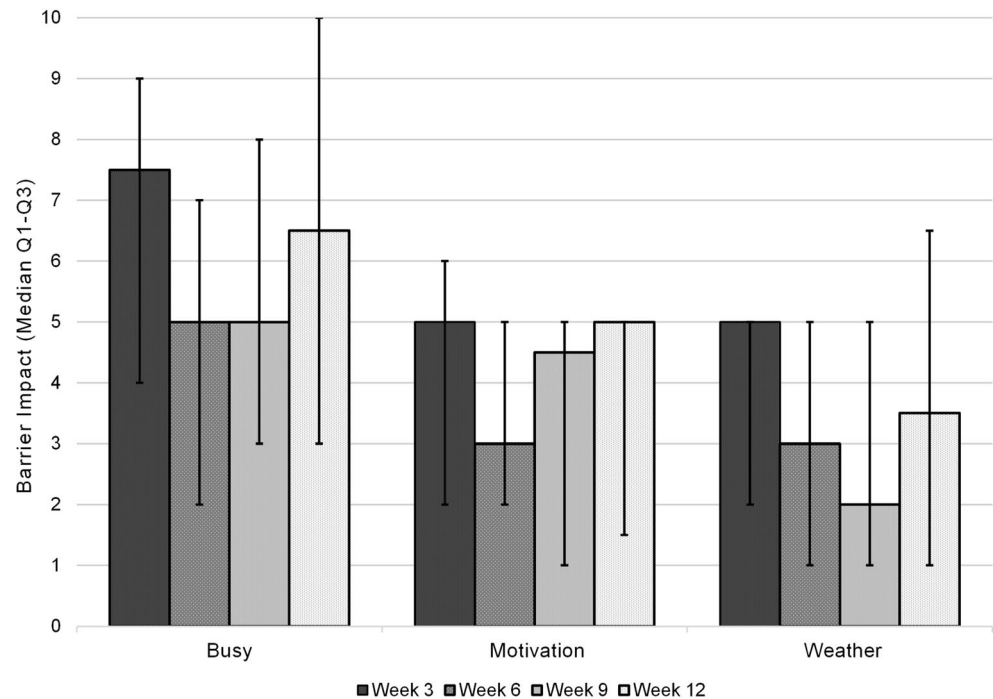
\*Of the 30 participants randomized to both physical activity interventions, 22 completed the diaries at each timepoint (3, 6, 9, and 12 weeks)

discussed by participants as a means for initiating physical activity. Margaret (higher intensity physical activity group) stated that “I was having trouble doing [physical activity] and I think the kick-start of the program helped me” she added that “I had been exercising but maybe not pushing myself hard enough.” Participants highlighted the importance of physical activity being monitored to produce accountability, as Chloe (higher intensity physical activity group) described that “you guys were watching me, so I can’t lie and say ‘oh yeah I totally went to the gym and did whatever’”. Olivia (control group) also explained that being in a study “was a way to answer to someone else.” She went on to mention how she had “to answer to this person [...] this is a study and I can’t not do this. Not only for myself, but [...] to not let somebody else down.” This feeling of obligation and responsibility created by the study was echoed in Grace’s (lower intensity physical activity group) sentiment that she “owed it to keep going, otherwise you’re wasting [...] time, money, effort and energy.” Similarly, some participants felt accountable to give

back to others by participating in BC-PAL. Grace said that she was motivated to participate “because I felt I cost the system so much, if I could go back in and provide some information, was a bit of a payback.”

With accountability came feelings of self-doubt as to whether or not participants would be able to achieve the physical activity prescriptions. Several participants expressed how “the 150 minutes a week is kind of freaky” and Chloe remarked that other breast cancer survivors may choose not to partake in a study like BC-PAL from “fear that they’ll fail.” She went on to explain that the biggest deterrent “would be, someone participating and fearing that they’re gonna mess up, and it’s bad data [...] they would probably feel like, they [...] sabotaged it, or screwed up. They’ve wrecked all of breast cancer.” The delivery of the intervention as part of a research study had implications for participants’ motivation to participate. Feelings of obligation to contribute to scientific knowledge, but also fear of not achieving study goals, had the potential to motivate, but also deter, study participation.

**Fig. 1** Impact of feeling busy, lack of motivation, and the weather on achieving physical activity goals at weeks 3, 6, 9, and 12 in the BC-PAL pilot trial ( $n = 22$ ), Calgary, Alberta, Canada, 2017–2018



**Power of results** Knowledge of study results and, by extension, progress throughout the study inspired participants to engage in physical activity. Amanda (lower intensity physical activity group) mentioned that with physical activity anything “to see that you have made some headway helps” whereas Olivia expressed that the results were “very educational. It was very eye opening.” These realizations were further articulated by Chloe as she recounted how “[physical activity] was surprisingly more effort than I thought it was going to be [...] but it was good because it made me realize how much time I need to actually put in to be healthy.”

**Reminders of cancer and moving beyond** Some aspects of BC-PAL served as negative reminders of lived breast cancer experiences while physical activity was viewed as a way to move beyond breast cancer. Amanda conveyed how living with breast cancer “is a change of life, it’s a new normal” and components of the study created conflict with this new reality. Chloe described how certain things act as triggers for cancer patients:

...people are bugged with the [activity trackers being the] colour pink, where other people that’s all they wear is pink. And [...] mail correspondents coming in [hospital], or Cancer Society white envelopes is shocking.

Grace further elaborated that “everything pink is gone.” Chloe clarified that generally people “don’t even think about

it. It’s like, oh this is just another pink thing” but how pink can act as a “reminder” of breast cancer. This issue was particularly relevant since only pink activity trackers were available at study initiation. Study recruitment through the Alberta Cancer Registry also produced negative reactions in some participants as Grace explained how breast cancer survivors “hate getting those white envelopes because of the fact it’s from [that address.] ‘Cause all your oncology letters came like that.” Amanda described how she tended “not to talk about cancer too often” and how physical activity “brings you more to your common place of, where you want to be and, where you should be and where you’ve been.”

### Influence of people

**Personal relationships** People in direct contact with participants during the study, such as study staff and friends/family living in the same household, had an impact on physical activity behaviors. Participants mentioned that the largest source of support was the study’s Exercise Testers. Despite BC-PAL being a home-based intervention, the involvement of the study team was important. For example, Grace mentioned that she liked the email communications “because it made me realize that you’re still aware of what’s going on, [Exercise Tester] is actually paying attention to me.” Furthermore, distant friends/family had less impact on physical activity behaviors. Margaret explained how the lack of peer support did not undermine her physical activity prescription, saying that “at first I wanted to have my friends help me, and then I found out that they weren’t available so I just did it on my own.”

**Self as a source of motivation** Participants themselves acted as a source of motivation as they expressed their desire to use physical activity to become healthy and make themselves feel better mentally, in addition to fulfilling a sense of personal accomplishment upon completing physical activity. Olivia expressed how she wanted to regain her health explaining that "...it was at the point where, I needed to get better and I needed to get healthier and I needed strength." She went on to say that she wanted "the strength to be able to get through the next years."

Margaret found that she "started to enjoy exercise again," and "felt better [...] mental health wise." The variations in participants' perceptions of mental health is evident in the contrast between Margaret's sentiment that "I don't think I was an unhappy person to begin with, but I'm happier" compared to Emma's explanation of how physical activity "helps with your mental capacity of how to take it and control it [...] I think the more active you are, the less you think about 'Am I gonna live, am I gonna die?'"

Lastly, physical activity facilitated personal fulfillment through a sense of control and accomplishment. Grace found that physical activity was her answer to the question of "what [are] you gonna do to make yourself feel better?" considering physical activity as a means to provide breast cancer survivors with a sense of control. Even after the caveat that physical activity "does feel like torture" Amanda expressed how "when you get out you feel so much better...and to know you did it, you did something" exemplified the personal fulfillment she felt.

### Wearable technology

**Objective insights into health** Wearable technology was identified as a tool to create self-awareness and reinforce physical activity. The activity tracker provided information not otherwise accessible to participants. Grace exclaimed that "it was really quite fascinating to see what they have come up with for you to monitor your own inner well-being so to speak." Wearable technology led to greater awareness of participants' physical responses to physical activity by providing continuous heart rate measurements which helped to encourage participants to challenge themselves. It was also used to increase awareness of physical activity volume, as Chloe discussed how she:

set goals, like mid-week if I wanna hit 150 [minutes] I should be at half that [...] and the application is on my phone and I can see what I've done [...] so it's really easy to track how well you're doing or how well you're not doing.

**Disconnect of person and technology** Wearable technology was also perceived as a source of judgment and failure by

participants. These sentiments often occurred when the device did not accurately reflect its user's physical activity, such as when Chloe was:

Out paddling and we're huffing and puffing and barely breathing and this isn't even triggering anything. So it shows [...] that our 150 minute goal is like 60 or half of that. But we've actually put in the effort and then you just give up after a while. Like there's no way I can make this.

Some participants found that wearable technology created a "distorted view" of how active they were, leading Chloe to "actually stop trying whatsoever." She explained that "I'm just failing - consistently." Grace revealed how her perception of the device shifted from positive reminders to judgment stating "I still do [exercise], I just don't need evaluation of myself anymore...because I knew what I was averaging." She clarified that "for now, I don't wanna be judged or evaluated or anything else... and then that will change ... It's just a case of you get tired of [judgment]."

## Discussion

Similar to previous research in breast cancer survivors [6], other cancer survivors [16], and healthy middle-aged Canadian women [17], feeling busy had the largest impact on physical activity adherence and was the only barrier BC-PAL participants rated as having greater than a neutral impact (i.e., > 5 in Fig. 1). The decrease in "feeling busy" as a barrier from weeks 1–3 to weeks 4–9 may be due to the participants becoming accustomed to their physical activity goals and better integrating physical activity into their everyday routines as the intervention progressed. The rebound in the "feeling busy" barrier at the end of the intervention may allude to participants who had become reliant on the intervention and may experience a lapse in adherence towards the end of the intervention as a result of relying on the motivation drawn from the intervention and study staff [18]. Although previous research has reported substantial impact of community factors (distance of center, traffic, time of class), these were not reported by participants in the current study, likely because of the home-based design of the physical activity intervention [6, 19]. Although supervised group exercises may provide additional social support and a sense of camaraderie compared to home-based physical activity interventions [20], social support from the exercise testers and family/friends at home was highlighted as a facilitator in this study.

The thematic analysis provided insights into how the study environment, influence of people, and wearable technology contributed to breast cancer survivors' acceptance and

adherence to a home-based physical activity intervention. We found that being a part of a research study primarily provided participants with feelings of accountability. The societal value given to health and research was extended to physical activity in this setting and created a sense of importance to achieving the prescribed physical activity goals [21]. This accountability was used as a catalyst for participants to become physically active. Some participants felt accountable to participate in research as “payback for costing the system.” These motivations to participate in research confirm previous study findings [5, 22]. Although remaining accountable to the study was often seen as a facilitator to participation, this responsibility also contributed to a fear of failure and self-doubt in some participants, especially those randomized to the higher intensity physical activity group who reported being intimidated by the physical activity intervention. This feeling may have been arisen because of the magnitude of change that had to occur for some participants from their previously inactive lifestyles. A common result of a cancer diagnosis is apathy towards physical activity because of the cancer-related side effects [19].

Participants expressed how seemingly ordinary items such as pink wristbands can “trigger” negative sentiments in breast cancer survivors. Wurz and colleagues [6] reported that breast cancer survivors identified a divide between them and the general population which they named a “cancer culture” and “cancer language.” In the current trial, participants acknowledged the permanency of living with breast cancer yet many expressed a desire to move past the “cancer culture” and recognized physical activity as a means to achieve this objective. Engaging in physical activity is an action that aligns with social norms in Canada [23]; therefore, being able to participate in BC-PAL was a means for breast cancer survivors to attain these acceptable norms and move away from the “cancer culture.” Breast cancer survivors in our study found that physical activity shifted their focus from sickness and disease to health and wellness and that this change in perspective created a sense of control, mental improvement, and personal fulfillment. These sentiments have been expressed from survivors of multiple cancer sites [20].

Consideration of the cultural and social meaning endowed in self-tracking practices helps to explain how wearable technology facilitates or interrupts physical activity behaviors. Lupton’s [21] concept of a “self-tracking culture” is evident as participants aligned with social norms of trusting wearable technology to monitor their physical self objectively. The lure of “numbers” is based on the perception that they are neutral and exact, rather than based on self-reported feelings and sensations. Self-tracking and objectivity have been identified to help people increase control and some even feel safer having their health monitored [21]. Both of these concepts were identified in our analysis and reflected the positive reinforcement of technology. Conversely, some participants rejected

wearable technology when they perceived a discrepancy between what they believed they were actually doing and the data provided by the device. While self-tracking has no meaning itself, we have given it value as a way of monitoring self-care [21]. Since adhering to self-tracking physical activity is an accepted social ideal, falling short of physical activity goals or feeling like the wearable technology is not properly measuring physical activity may be perceived as failing to achieve one’s *best self*.

## Limitations

Four participants (one randomized to the higher intensity physical activity group, two randomized to the lower intensity physical activity group and one randomized to the control group) were approached but chose not to participate in the semi-structured interviews. Reasons for refusal were not recorded by study staff; however, it is hypothesized that the breast cancer survivors who chose to participate were more likely to be motivated to change their physical activity behaviors. The primary interviewer (CS) had no previous interaction with participants, which may limit CS’s rapport with participants and subsequent depth of conversation yet may increase the participants’ comfort in disclosing things that may have been difficult or they did not like. Limiting the number of semi-structured interviews ( $n = 6$ ) facilitated in-depth analysis of participants’ experiences; however, additional perspectives and themes may have been identified with a larger number of interviews.

Eight participants (26.6%) within the intervention arms did not complete or return their diaries. The diaries were originally intended as a physical activity intervention tool, and their use was discretionary. We also did not provide these diaries to the control group during the intervention since we did not want this tool (or the tracking of physical activity habits, facilitators, and barriers) to impact their physical activity behaviors. Lastly, the 12-week design of BC-PAL limits our ability to assess whether the utilization of wearable technology is sustainable for breast cancer survivors over the long term.

## Conclusion

With the recent introduction of wearable technology into physical activity interventions and enthusiasm for their potential utility in physical activity promotion, understanding participants’ experiences in trials such as BC-PAL has increasing importance. To our knowledge, this study is the first to explore breast cancer survivors’ perceptions of a home-based physical activity intervention that used wearable technology. Participants provided insights into the impact of the study environment, suggesting that future studies using wearable

technology should act to mitigate the concerns of failure and self-doubt and focus on promoting the devices to create accountability and encouragement. Access to daily results from the wearable activity tracker motivated participants to continue participating in physical activity throughout the intervention. Furthermore, providing participants with their cardiopulmonary fitness measurements and other study results at baseline and end of the study helped to demonstrate the progress participants had made as a result of this physical activity intervention. This aspect should be incorporated into future interventions since monitoring progress acted as a facilitator of adherence in the current study. We corroborate with previous researchers [16, 24] that it is essential to understand the realities and “triggers” of participants to inform future physical activity interventions and recruitment strategies. Lastly, we observed that wearable technology can act both as a facilitator and a deterrent for health; therefore, the implementation strategies of wearable technology should be considered a priori for best practice within this population.

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## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflicts of interest.

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