# Fitbit Usage in Patients With Breast Cancer Undergoing Chemotherapy

Nickolas Dreher,[1] Edward Kenji Hadeler,[1] Sheri J. Hartman,[2] Emily C. Wong,[1] Irene Acerbi,[1] Hope S. Rugo,[1] Melanie Catherine Majure,[1] Amy Jo Chien,[1] Laura J. Esserman,[1] Michelle E. Melisko[1]

## Abstract

**Fitbits may be useful in tracking changes in physical activity during chemotherapy. Sixty-five patients with breast cancer were given Fitbits at the start of chemotherapy, but adherence to wearing the Fitbit was low, with mean number of valid days across the 9-month study period of 44.5%. Interventions to increase wear are likely necessary in the active treatment setting.**

**Background:** Many patients' activity levels decrease during chemotherapy. Wearable devices, such as Fitbits, track activity patterns and may encourage behavior change. This study aimed to determine the utility of using Fitbits to measure physical activity and sleep throughout chemotherapy. **Patients and Methods:** Patients with early stage breast cancer were enrolled prior to starting chemotherapy. Patients received a Fitbit Charge HR and were instructed to wear it and sync at least weekly throughout chemotherapy and up to 6 months post therapy. Patients completed baseline surveys, and treatment information was collected from their medical records. Fitbit data was downloaded from the Fitabase data management platform. To assess utility, we evaluated how many days patients wore their Fitbit for at least 10 hours. **Results:** Adherence to wearing the Fitbit was low, with 16.9% of patients never syncing their device. For those who did sync, the mean number of valid days ($>$ 10 hours of use) across the 9-month study period was 44.5% (SD, 36.9%), and the median was 39.6%, with a range of 0% to 100% of the total study days. Adherence was higher among participants receiving adjuvant chemotherapy versus neoadjuvant chemotherapy (51.9% vs. 29.6% valid days, respectively [$P =$ .037]). Baseline questions indicating positive attitudes toward technology were significantly correlated with higher adherence. **Conclusions:** Fitbit use during breast cancer chemotherapy was poor in the absence of prompts to encourage wear. Interventions including phone calls, texts, or other reminders to maintain adherence are likely necessary to increase wear in active treatment settings.

## Introduction

Cancer and cancer treatment are known to significantly impact quality of life (QoL). Over 80% of patients with breast cancer in active treatment report fatigue, with a majority reporting moderate to severe fatigue.[1] Chemotherapy induces fatigue, anxiety, depression, and other adverse events in many patients.[2,3] Physical activity has been shown to alleviate the side effects of chemotherapy and improve QoL.[4-9] Exercise interventions have primarily been linked to reductions in cancer-related fatigue,[4-7] but there is also evidence of positive cognitive effects.[9,10]

Many patients' activity levels decrease during chemotherapy.[11,12] A study of over 1600 women receiving breast cancer treatment noted a 2.12 hour a week decrease in moderate to vigorous physical activity, based on self-reporting, among patients receiving chemotherapy.[11] More insight into patterns of physical activity is needed, but measurement of unsupervised physical activity presents various challenges. Patient-reported data acquired through infrequent questionnaires may not be detailed or reliable enough for accurate analysis, and more frequent self-reporting methods using cell phone apps have proven too burdensome to maintain compliance. Other devices such as ActiGraph accelerometers can objectively measure free-living physical activity, but they are limited by their ability to only collect continuous data for short periods of time.[13]

[1]University of California, San Francisco, San Francisco, CA
[2]University of California, San Diego, La Jolla, CA

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Address for correspondence: Nickolas Dreher, BA, Mount Sinai, 50 E 98th St, #5B1, New York, NY 10029
E-mail contact: Nickolas.Dreher@icahn.mssm.edu

# Fitbit Usage During Chemotherapy

Wearable activity trackers such as the Fitbit record data, including number of steps walked, number of floors climbed, heart rate, sleep duration, and other fitness metrics. These devices can collect minute-level data for months, compared with traditional accelerometer measures that collect data for about a week. By recording daily, objective activity data for extended periods of time, Fitbits can shed light on activity patterns and provide important feedback for patients and physicians alike. The primary aim of this study is to investigate the utility of using Fitbits to track patient activity during and up to 6 months after completion of chemotherapy for patients with early stage breast cancer. Additionally, these data were used to illuminate trends in adherence that could be used to improve this utility in the future. Finally, several methods of measuring adherence were compared to better understand how to most accurately assess this utility in future studies.

## Patients and Methods

English-speaking patients with stage 1 to 3 breast cancer who were scheduled to begin a chemotherapy regimen lasting at least 12 weeks at the University of California, San Francisco (UCSF) Breast Care Center and who had access to a smart phone or computer were eligible to participate. The study was approved by the UCSF Institutional Review Board prior to patient enrollment. Patients provided written, informed consent and were given a Fitbit Charge HR or Charge 2 along with instructions on Fitbit setup on and how to sync either with their smartphone or home computer on or before their first day of chemotherapy.

Upon consent, participants were asked to wear the Fitbit as much as possible and sync their device at least 2 times per week from the first day of chemotherapy, during, and up to 6 months after completion of chemotherapy depending on their regimen. Fitabase (Small Steps Lab, San Diego, CA), was used to extract activity and download data from the patient's Fitbit profile. Participants were also sent a survey via email through the secure web application Research Electronic Data Capture (REDCap) on the first day of chemotherapy to gather demographic information and attitudes toward information technology at baseline. Specific questions from the baseline survey are available in the appendix (see Supplemental Table 1 in the online version), and they assess participants' prior exposure to information technology, beliefs about the utility of information technology, and prior use of Fitbits or other wearable activity trackers.

We evaluated the utility of using the Fitbit to monitor physical activity and sleep during chemotherapy in several ways. We calculated the percentage of patients who never synced their device, and among patients who did sync, steps and heart rate data were used to determine adherence. Because patients were instructed to wear the Fitbit at all times, not simply during physical activity, wear time per day was chosen to determine if data reported for any given day was valid. A day was considered valid if the participant wore their Fitbit for 10 hours a day or more, as determined by heart rate data recorded each minute. The Fitbit Charge HR and Charge 2 can store activity, heart rate, and sleep data for up to 30 days, so patient data is not lost even if syncs are infrequent. However, if syncs are more than 7 days apart, data is aggregated such that heart rate data is reported as 15-minute averages and some step and sleep data granularity is also lost. These 15-minute averages were deemed sufficient for measuring hours of use for this study. No phone calls, e-mails, texts, or other reminders to wear or sync the Fitbit were conducted because the primary aim of the study was to explore the utility of using the Fitbit to collect physical activity and sleep data without prompting by the study team.

## Results

### Participant Characteristics

Sixty-five women gave written consent for the study between August 2016 and January 2018. The average age of participants was 50.4 years, and they were predominantly white (79.6%) or Asian (14.8%). The demographics and tumor characteristics of these women are reported in Table 1. All participants received an intravenous chemotherapy regimen that included a taxane,

| Table 1 | Baseline Characteristics of Study Participants (N = 65) |
|---|---|
| **Patient Demographics** | |
| **Age, y** | |
| Mean | 50.4 |
| Median | 49.0 |
| Range | 29-72 |
| **Race** | |
| White | 43 (66%) |
| Asian | 8 (12%) |
| Black | 1 (2%) |
| Other | 2 (3%) |
| Unknown | 11 (17%) |
| **Chemotherapy Regimen** | |
| Chemotherapy type | |
| Taxol/AC ± monoclonal agents | 30 (46%) |
| Taxotere/Cytoxan | 12 (19%) |
| Docetaxel/Carboplatin/Herceptin ± perjeta | 10 (15%) |
| Other | 13 (20%) |
| Neoadjuvant | 45 (69%) |
| Adjuvant | 20 (31%) |
| **Tumor Characteristics** | |
| Receptors | |
| HR⁺ HER2⁻ | 24 (37%) |
| HER2⁺ | 21 (32%) |
| HR⁻ HER2⁻ | 20 (31%) |
| Tumor grade | |
| 1 | 2 (3%) |
| 2 | 32 (49%) |
| 3 | 31 (48%) |
| **Technology Preferences[a]** | |
| Positive attitude toward information technology | 50 (94%) |
| Exposure to information technology | 47 (89%) |
| Prior Fitbit use | 37 (69%) |

Abbreviations: AC = doxorubicin and cyclophosphamide; HER2 = Human epidermal growth factor receptor 2; HR = hormone receptor.
[a]Technology preferences only available for 54 of 65 participants.

anthracycline, or some combination of the 2. The specific regimens were not controlled, and patients received varying doses and duration, including some novel therapies administered in ongoing clinical trials. Fifty-four women successfully completed the baseline survey, so technology preferences and self-reported race were not available for 11 participants.

### Patterns in Fitbit Use

Eleven (16.9%) participants never synced their Fitbit, resulting in no data for the duration of the study. The number of participants reporting data dropped steadily over time. Step data was reported (range, 0-35,953 steps per day) for 83.1% of participants at any time in the first week of the study. However, only 27.7% of participants reported steps in the final week. A 0-step day indicates that participants synced their Fitbit within 30 days but did not actually wear it on that day. Figure 1 depicts the number of patients who reported step data for each day of the study (days 0-270 from study start through treatment and 6-month follow-up). Similarly, 70.8% of participants had heart rate data available in the first week, compared with only 18.5% of participants in the final week. Heart rate data is only available if patients are actively wearing the device, whereas step data is available as long as the device is synced. Figure 2 depicts the number of patients who reported heart rate data for each day of the study (days 0-270 from study start to 6-month follow-up). Figures 1 and 2 show a steady decline in the number of patients reporting data as the study progresses. If participants stopped reporting step or heart rate data, they would maintain this non-use throughout the study.

### Overall Adherence

Ultimately, adherence to wearing the Fitbit was low, with a mean number of valid days (defined as > 10 hours of heart rate data) across the 9-month observation period of 44.5% (SD, 36.9%), a median of 39.6%, and a range of 0% to 100% of the total study days in participants who synced at least once. Even in the first month of the study, when adherence was highest, the participants wore the Fitbit > 10 hours per day, on average, 15.5 out of 30 days (51.7% of the month). Figure 3 shows the total number of patients with valid days for each day of the study.

Adherence was higher among all participants receiving adjuvant chemotherapy versus neoadjuvant chemotherapy; 51.9% versus 29.6% valid days, respectively ($P = .037$). Adherence was also higher among all participants under 50 years of age when compared with those 50 years of age or older (44.2% vs. 28.4% valid days, respectively), but this did not reach statistical significance ($P = .225$). Furthermore, adherence was correlated with answers to 2 baseline survey questions. Patients who agreed with the statement "I constantly have to deal with information technology" went on to record 129.9 (48.1%) valid days on average versus only 16.2 (6.0%) valid days in those that disagreed ($P = .016$). Likewise, patients who agreed with the statement "I think information technology is indispensable today" recorded 121.8 (45.1%) valid days on average, compared with only 37.0 (13.7%) in those who disagreed ($P = .031$).

### Sensitivity Analysis of Adherence Measures

Various definitions of a "valid day" were tested to investigate the sensitivity of different adherence thresholds. Two common thresholds used in the literature, > 10 hours of wear time or > 2000 steps in a day, returned similar results. However, step analysis seemed to be the slightly less stringent of the 2, indicating that the mean number of valid days was 49.4% (> 2000 steps in a day) compared with 44.5% based on heart−rate-derived wear time (> 10 hours in a day).

Decreasing the valid day threshold for either steps or wear time did not have a large effect on the results. As depicted in Figure 4, defining valid days as more than 1 step in a day was similar to defining them as more than 2000 steps in a day, with mean valid days of 53.5% versus 49.4%, respectively. Similarly, there was no major difference between wear time higher than 6 hours or higher than 10 hours, with mean valid days of 48.2% versus 44.5%, respectively (see Supplemental Figure 1 in the online version).

### Capture of Sleep and Other Supplemental Data

Sleep data, determined by Fitbit based on movement patters and heartrate, was available for 50 (76.9%) participants at any point during the study. However, only 28 (43.0%) participants logged more than 30 nights worth of sleep data. Also, participants did not

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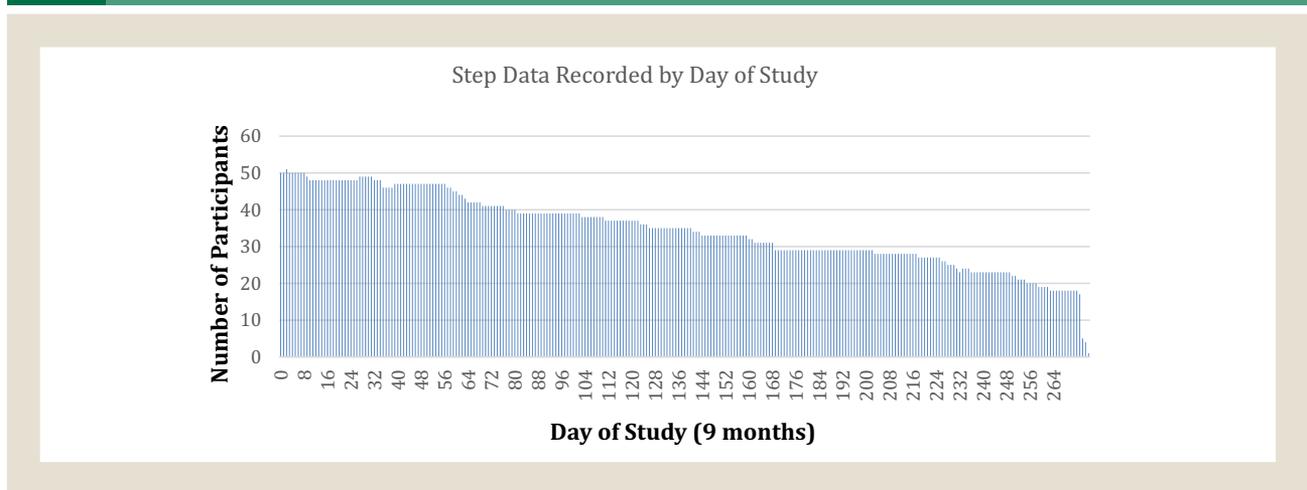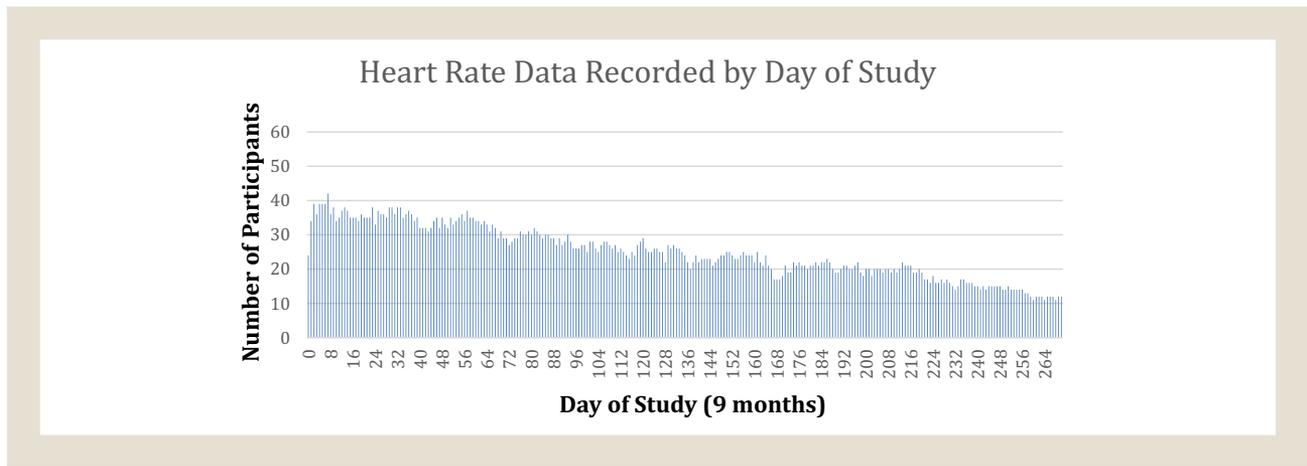**Figure 1  Step Data Reported for Each Study Day**



Step Data Recorded by Day of Study

**Figure 2** | **Heart Rate Data Reported for Each Study Day**



Heart Rate Data Recorded by Day of Study

**Figure 3** | **Patients Wearing Fitbit > 10 Hours Per Day Reported for Each Day of Study, as Derived From Heart Rate Data**
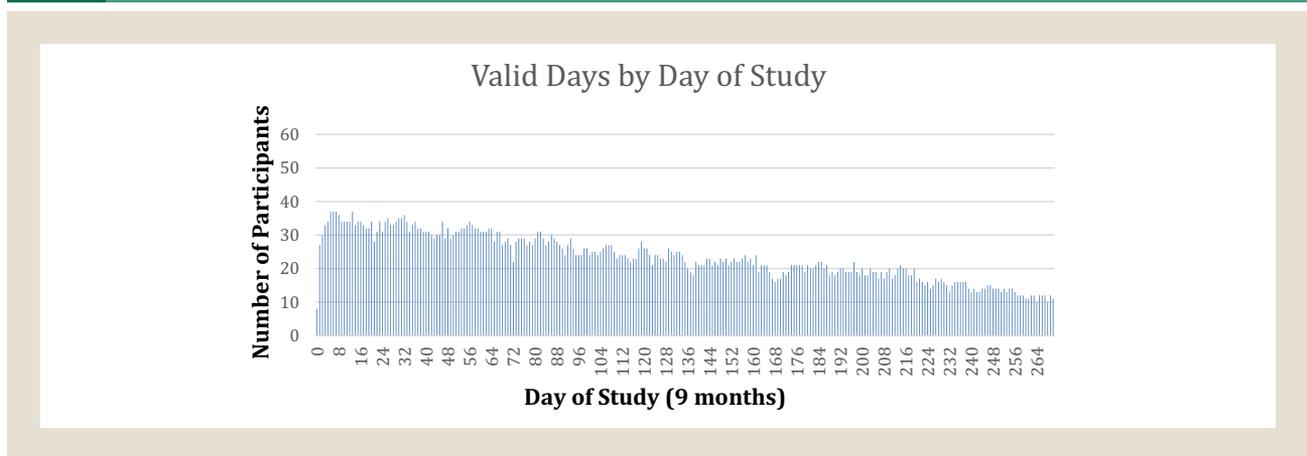


Valid Days by Day of Study

frequently utilize self-reported fields built into the Fitbit software. For example, only 1 patient updated the weight field on their Fitbit profile after setting up their account, and any changes in weight must be entered manually.

## Discussion

This study evaluated adherence to Fitbit use during adjuvant or neoadjuvant chemotherapy in patients with early breast cancer and did not incorporate reminders or interventions to increase wear time or sync rates. Adherence based on valid days (> 10 hours of use in a day as determined by heart rate data) over a 9-month span was low, with a mean of 44.5% (SD, 36.9%) of the total study days.

Adherence was significantly correlated with timing of treatment, with neoadjuvant patients displaying lower adherence than adjuvant patients. Also, 2 belief statements, "I constantly have to deal with information technology" and "I think information technology is indispensable today," were significantly correlated with adherence.

Our primary measure of adherence was based on a 10-hour wear time threshold that is often considered a valid Actigraph day, but the same overall trends are observed regardless of which metrics we employ. There is a gradual decline in the number of patients reporting step data regardless of the threshold set (> 0, > 1, > 100, > 1000, or > 2000 steps per day). Likewise, differing wear time thresholds (> 0, > 6, or > 10 hours as determined by heart rate data) showed the same pattern, indicating that setting a lower threshold for a valid day may not significantly affect results.

Our study is the first to evaluate adherence to Fitbit use during adjuvant or neoadjuvant chemotherapy in patients with early breast cancer in which patients were asked to wear and perform the Fitbit data sync function independently without the incorporation of reminders or interventions to increase wear time or sync rates. In our study, adherence to wearing the Fitbit over a 9-month span was low, with a mean number of valid days (defined as > 10 hours of heart rate data) across the 9-month observation period of 44.5% among participants who synced at least once.

Using similar measures of adherence, previous studies have demonstrated greater adherence to wearing the Fitbit over the course of the study period. For example, in a 12-week study of 42 survivors of breast cancer within 5 years of diagnosis who were assigned to the exercise intervention arm of a randomized controlled trial, the mean adherence to wearing the Fitbit was 88.13% of valid days over 12 weeks (SD, 14.49%).[14] In a similarly designed study of 25 overweight or obese postmenopausal women enrolled in the intervention arm of a randomized 16-week

**Figure 4** | **Sensitivity Analysis of Step Thresholds**



### >2000 Steps by Day of Study

### >100 Steps by Day of Study

### >1 Steps by Day of Study
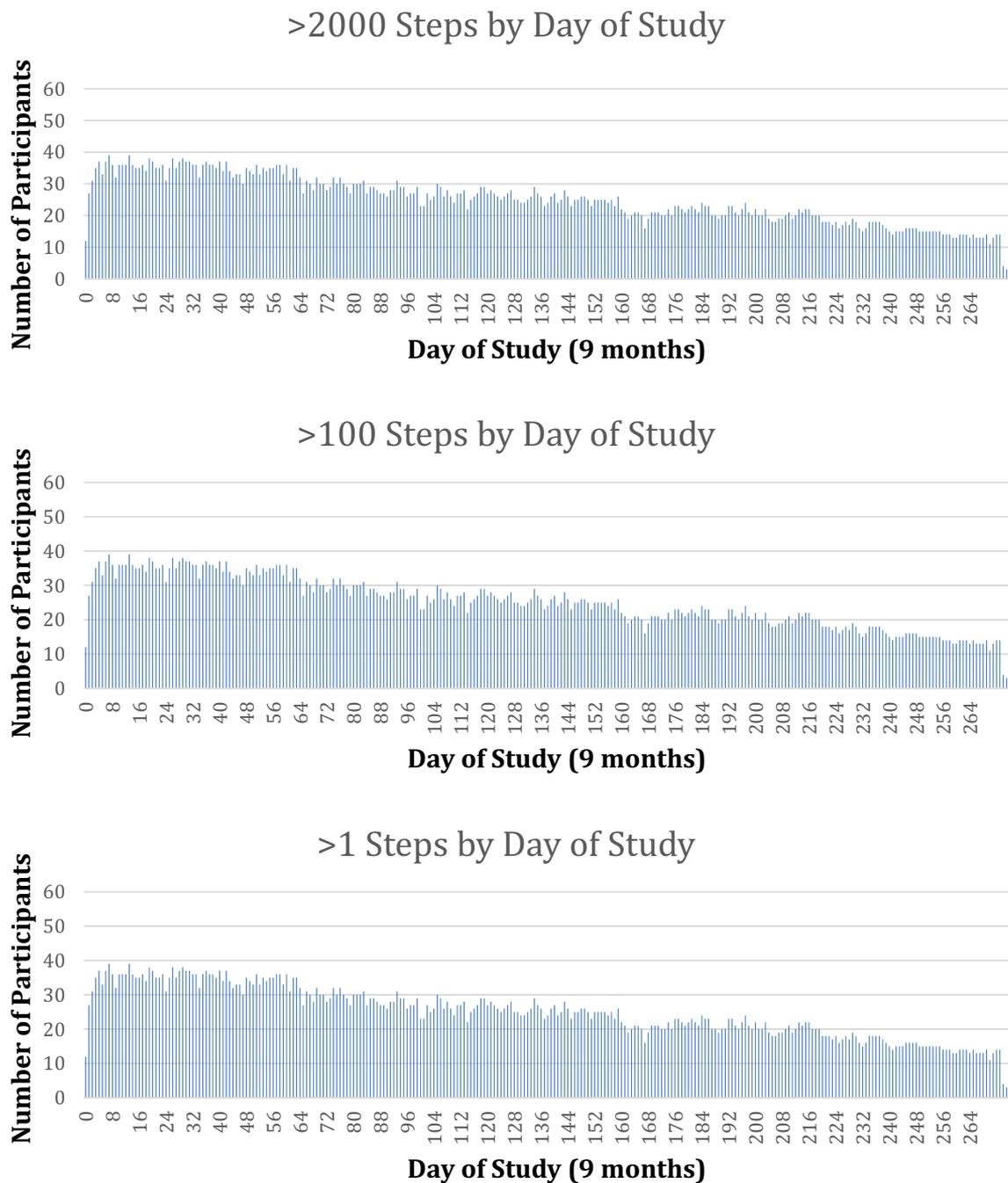
physical activity intervention trial, 95% of participants logged 10 hours or more per day of Fitbit wear over the 112 intervention days with no significant decline in wear over the study period.[15] In a study of 22 free-living men undergoing active surveillance for localized prostate cancer in which the goal was to validate the Fitbit One's measures of physical activity over 7 days, the reported "wear time" was 5.8 days (82.8% of the total study period).[16] In a study of 127 patients with early stage breast cancer undergoing

adjuvant or neoadjuvant chemotherapy, patients were provided with a Fitbit Zip. Fitbit steps were uploaded during chemotherapy visits and summed by week. This study reported that 79% of participants had analyzable Fitbit data,[17] but no details are provided regarding Fitbit wear time or average number of days where the Fitbit was worn.

In both the Hartman and Cadmus-Bertram studies, there was significant interaction between the study staff and research

participants throughout the study period in the form of phone interviews, follow-up calls and reminders, and/or individualized planning/goal setting sessions.[14,15] In the previous study of patients with breast cancer wearing a Fitbit Zip during chemotherapy, patients were given a "walking goal" of 150 minutes per week, a motivational flyer, workbook, and exercise logs to complete.[17] Most importantly, patients were not required to sync their device by themselves, but rather the sync occurred during a chemotherapy visit, eliminating one potential obstacle to adherence. Although the study of patients with prostate cancer did not report utilizing reminders via text, phone, or e-mail to motivate patients to wear the Fitbit One, the study intervention period was only 7 days, which is substantially shorter than our study.[16] The lower adherence seen in our study is at least partially attributable to the intentional lack of reminders and interventions.

Although several previous studies focused on overweight non-cancer populations or breast cancer survivors who had completed the acute phase of care, our study focused on patients with breast cancer undergoing active treatment with chemotherapy. Although physical activity during chemotherapy has been shown to mitigate side effects and improve QoL,[10] the start of chemotherapy is often a hectic and stressful time, and without reminders through phone calls, texts, or e-mails, adherence to wearing the Fitbit may not be a priority for patients. Our finding that wear time was higher in patients undergoing adjuvant as compared with neoadjuvant chemotherapy supports a hypothesis that the additional task of wearing and syncing a Fitbit is less of a burden to patients who are further out from their diagnosis of breast cancer.

Multiple studies have demonstrated increased physical activity when patients are engaged in an exercise or lifestyle intervention involving personal trainers and/or in-person or telephone coaching sessions. In a meta-analysis of physical activity and behavior change interventions in recent post-treatment survivors of breast cancer, an exploratory analysis stratified studies by low, intermediate, and high levels of supervision/monitoring during the intervention and found that studies in the high supervision group had the largest effect sizes.[18] There is a great need to identify cost-effective ways of motivating patients to increase their physical activity level. The promise of wearable devices is to impact behavior without significant intervention or investment of human resources. The low adherence to Fitbit wear seen in our study suggests that providing patients with a wearable device alone is unlikely to be sufficient to be an effective tool to support changing physical activity in this setting. This was similarly observed in a study of 138 diabetic or pre-diabetic patients who were given a Fitbit and randomized to receive the Fitbit only, Fitbit with text-message reminders to wear the device, or Fitbit with both reminders to wear the device and to set goals for steps per day. Although subjects in the reminder arm wore their Fitbits on 25% more days than the Fitbit-only group, there was no difference between any of the arms in the number of steps taken per day.[19]

Another notable trend identified in this study is the difference in "valid days" for patients based on age. Patients under 50 years were more adherent than patients over 50 years, though this was not statistically significant. This trend may be owing to higher levels of comfort with and understanding of the use of technology among younger participants. This is supported by the fact that patients who agreed with the statements, "I constantly have to deal with information technology" or "I think information technology is indispensable today," had greater adherence than those who did not agree with these statements. In designing future studies and interventions that depend on wearable devices, attention should be paid to patients' experience with and willingness to interface with electronics and technologies.

### Limitations

Because this study was largely a pilot investigation to explore the acceptability and utility of collecting data using the Fitbit in patients with early stage breast cancer undergoing chemotherapy, we did not establish an a priori definition of what would be considered acceptable adherence to Fitbit wear. Rather, we employed definitions of adherence that were used in studies of overweight women and a survivorship population, which may not be appropriate for patients in active cancer treatment.

We did not incorporate any survey questions or qualitative interviews with patients at the end of the study to better understand their perceptions of the feasibility and acceptability of Fitbit wear during their months of chemotherapy.

Additionally, our study results are slightly confounded in that there were 6 (9.2%) patients who experienced device malfunction (broken band, lost charger), such that some opportunity to comply with wear was lost until the device could be repaired or replaced.

## Conclusions

Our study demonstrated that the Fitbit may not be an appropriate tool to support tracking physical activity during chemotherapy owing to the poor compliance with wear. However, previous studies indicate that use in less treatment-intensive settings and/or augmented by reminders may increase compliance.

Future studies should be informed by 3 trends found in these data. First, there was steady drop-off of study participants over time, and participants who stopped reporting data generally did not return to compliance on their own. Second, there was decreased adherence in patients undergoing neoadjuvant compared with adjuvant therapy. Third, patients with favorable attitudes toward technology, quantified by 2 specific baseline questions, went on to have higher adherence.

### Clinical Practice Points

- Physical activity is known to decrease during chemotherapy, despite its beneficial effects of reducing side effects and improving quality of life overall. Fitbits have been purposed as a means of characterizing these changes in activity, and even inciting behavior change. However, burdensome active therapies such as chemotherapy pose potential barriers to sustained Fitbit use.
- Adherence to wearing the Fitbit was low in the active treatment setting. Over a 9-month study period, the average patient logged at least 10 hours of wear on only 44.5% of days. This trend was consistent across several adherence thresholds, including 1-step days. The average patient logged at least 1 step on only 53.5% of days. Adherence decreased steadily over time, but was higher in patients undergoing adjuvant chemotherapy than those

undergoing neoadjuvant chemotherapy. Two baseline questions indicating positive attitudes toward technology were also associated with higher adherence.

- Future studies that intend to employ Fitbits in the active treatment setting should be wary of adherence in the absence of incentives or regular reminders. These findings can be used in trial design to improve patient screening, guide reminder protocols, and appropriately measure adherence.

## Acknowledgments

## Disclosure

The authors have stated that they have no conflicts of interest.

## Supplemental Data

Supplemental figure and table accompanying this article can be found in the online version at https://doi.org/10.1016/j.clbc.2019.05.005.

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## Supplemental Data

| Supplemental Table 1 | Technology Exposure and Attitudes Questions From Baseline Survey |
|---|---|
| **Question Text** | **Response Type** |
| Overall, I think information technology brings about some benefits. | Agree/Disagree (Likert Scale) |
| I think information technology is indispensable today. | Agree/Disagree (Likert Scale) |
| I constantly have to deal with information technology. | Agree/Disagree (Likert Scale) |
| The Fitbit could help in reaching my objectives. | Agree/Disagree (Likert Scale) |
| The Fitbit could improve my performance. | Agree/Disagree (Likert Scale) |
| The Fitbit could improve the quality of my activity. | Agree/Disagree (Likert Scale) |
| Have you ever used a pedometer or other wearable fitness tracker? | Yes/No |

| Supplemental Figure 1 | Sensitivity Analysis of Wear-Time thresholds |
|---|---|



>10 Hours Wear Time by Day of Study

>6 Hours Wear Time by Day of Study

≥1 Hours Wear Time by Day of Study