A randomized controlled trial of WATAAP to promote physical activity in colorectal and endometrial cancer survivors

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Abstract
Objective: The objective of this study was to ascertain whether wearable technology coupled with action planning was effective in increasing physical activity (PA) in colorectal and endometrial cancer survivors at cardiovascular risk.

Methods: Sixty-eight survivors who had cardiovascular risk factors and were insufficiently active were randomized to intervention and control arms. Intervention participants were given a wearable tracker for 12 weeks, two group sessions, and a support phone call. Participants in the control arm received print materials describing PA guidelines. Assessments at baseline and 12 weeks measured triaxial and uniaxial estimates of moderate-vigorous physical activity (MVPA), sedentary behaviour, blood pressure, and body mass index (BMI).

Results: The intervention group significantly increased MVPA by 45 min/wk compared with a reduction of 21 min/wk in the control group. Group by time interactions were significant for minutes of MVPA (F1,126 = 5.14, P = 0.025). For those with diastolic hypertension, there was a significant group by time interaction (F1,66 = 4.89, P = 0.031) with a net reduction of 9.89 mm Hg in the intervention group.

Conclusions: Significant improvements in MVPA were observed following the intervention. The results display promise for the use of pragmatic, low-intensity interventions using wearable technology.

KEYWORDS

cancer, cardiovascular diseases, exercise, oncology, wearable technology

1 | INTRODUCTION

Physical activity (PA) reduces the risk of cardiovascular disease (CVD),1 cancer, and cancer-related death.2 In cancer survivors, PA may reduce the risk of recurrence.3 Sedentary behaviour may be an independent risk factor for cancer occurrence and mortality.3 However, many cancer survivors fail to meet the current guidelines of >150 minutes of moderate-intensity PA per week,4 and some are sedentary.5

Although survival rates are increasing, many colorectal and endometrial survivors have comorbidities and lifestyle-related risk factors for CVD including insufficient PA, sedentary behaviour, poor diet, and obesity.2,6,7 More than 58% and 63% of colorectal and endometrial survivors respectively are overweight or obese.8 Further, approximately
50% and approximately 70% of colorectal and endometrial survivors respectively are insufficiently active, putting these survivors at risk for CVD. In a retrospective cohort study of more than 30,000 endometrial cancer patients, CVD was the leading cause of death.\(^7\)

Most PA interventions in cancer survivors are facility based, supervised, or group based,\(^11\) despite survivors identifying barriers around cost, accessibility, and intimidation.\(^12\)\(^,\)\(^13\) Many survivors express a preference for unsupervised, self-paced, low-intensity PA, specifically walking.\(^14\)\(^,\)\(^15\) Home-based interventions may mitigate barriers to exercise, complement exercise preferences, and facilitate exercise adherence.\(^15\)\(^,\)\(^16\) There is a gap in knowledge concerning the effectiveness of less-intensive home-based interventions that may be more cost-effective and scalable.

Wearable activity trackers (wearables) hold potential as a low-cost self-monitoring tool, with their associated applications (Apps) offering several evidence-based behaviour change techniques (BCTs) including goal setting, feedback, self-monitoring, and social support.\(^17\)\(^,\)\(^18\) As such, wearables could represent a cost-effective and scalable intervention. However, several evidence-based BCTs are not integrated into Apps including action planning, coping planning, and instruction on performance of the behaviour.\(^17\) Because of these omissions and other patient barriers including dwindling motivation, wearables alone might be insufficient to produce long-term PA engagement.\(^19\) The present trial included two group sessions to include these BCTs that are largely omitted from wearables and their associated Apps.

Reviews of trials incorporating wearables support the effectiveness of trackers for increasing PA\(^20\) and reducing sedentary behaviour.\(^21\) There is evidence to support the effectiveness of wearables for increasing PA among adults with chronic disease,\(^22\) postmenopausal women,\(^23\) and in breast cancer survivors.\(^24\)\(^,\)\(^25\) Research on "smart" wearables in survivors has thus far been limited to predominantly breast survivors and has not involved group sessions as components of the intervention. Our trial is novel because it includes group sessions and relational support\(^26\) and the inclusion of BCTs (eg, action planning) that are absent from wearables and their Apps. To our knowledge, our trial is the first to combine "smart" wearables with group sessions, in a pragmatic, low-intensity intervention to improve PA and reduce sedentary behaviour in colorectal and endometrial cancer survivors. The primary aim of the Wearable Activity Technology and Action Planning (WATAAP) trial was to ascertain whether wearable technology, in conjunction with instruction on how to perform behaviour, action planning, goal setting, and coping planning, was effective in increasing moderate-vigorous physical activity (MVPA) and reducing sedentary behaviour in colorectal and endometrial survivors at cardiovascular risk. A secondary aim was to assess the effectiveness of the intervention for reducing blood pressure and body mass index (BMI).

## METHODS

The trial was a two-arm, multicentre randomized controlled trial (RCT), conducted in Perth, Western Australia. The study was approved by the St John of God Human Research Ethics Committee (reference no. 1102) and registered (ANZCTR2617000131358). Written informed consent was obtained from participants prior to enrolment.

### 2.1 Participants

Participants included stage 1 or 2 colorectal or endometrial cancer survivors who had completed active cancer treatment within the 5 years prior to recruitment and were deemed insufficiently physically active and at CVD risk. The full eligibility criteria have been previously published.\(^27\)

### 2.2 Recruitment

Eligible survivors were identified from oncologists' medical records and were mailed a participant information sheet and invitation letter. Individuals who expressed interest were screened by telephone to ensure eligibility prior to recruitment from July 2017, with assessments in December 2017 and March 2018.

### 2.3 Randomization

Following baseline assessments, an independent statistician who was blinded to the assessments and intervention randomized participants using consecutive randomization codes (STATA v14) with a 1:1 allocation in blocks of 4.

### 2.4 Design

#### 2.4.1 Intervention arm

The 12-week intervention consisted of three components, which have previously been described.\(^27\)

1. The Fitbit Alta is a wrist-worn tracker that is cost-effective, with demonstrated acceptability for use by cancer survivors.\(^28\) The tracker records daily steps, MVPA accrued in bouts of ≥10 minutes (active minutes), and distance and provides automated prompts encouraging participants to accumulate ≥250 steps per hour. Participants received and set up their Fitbit during group session 1 using their phone, tablet, or computer. Fitbit engagement data were collected daily via the Fitbit Dashboard following participants' acceptance of a friend request with a study investigator.

2. Participants attended 2-hour group sessions (approximately 11 per group) facilitated by behaviour change specialist S.J.H. and C.M.S. in weeks 1 and 4. Session 1 involved Fitbit set-up and presentation on PA messaging, instruction on performance of the behaviour, goal setting, confidence building, action planning, coping planning, and self-monitoring of active and sedentary behaviour. Emphasis was given to reducing bouts of sedentary behaviour and responding to the automatic prompts to take steps, in addition to...
encouraging planned bouts of MVPA. Participants were assisted to complete action-planning and goal-setting activities. Session 2 focused on reviewing goals, forming "if-then" plans to overcome barriers, on the basis of our previous research. Home-based strength exercises were demonstrated with an opportunity for practice, and participants were encouraged to log strength training manually on the Fitbit app.

3. Participants received a 20-minute phone call during week 8 to provide support and feedback regarding PA progress, review goals, action plans, and coping-planning strategies.

2.5 | Control arm

This group received print materials containing PA guidelines (also given to the intervention group) but was not specifically encouraged to increase their PA. Printed materials included examples of home-based aerobic and strength training and worksheets to self-monitor and self-regulate PA engagement.

2.6 | Assessments

Data collection was performed during 30-minute assessments at baseline (T1) and 12 weeks (T2). Assessments postrandomization was conducted at St John of God Subiaco Hospital by hospital staff blinded to group allocation, who measured height (only at T1), weight, and blood pressure. Participants were given an ActiGraph Link GT9X accelerometer, waistband, log, and postage materials. Participants were instructed to wear the accelerometer on their right hip for all waking hours across seven consecutive days before posting the accelerometer back to the research team.

2.7 | Outcome measures

2.7.1 | Physical activity

Minutes per week of MVPA were ascertained from the ActiGraph GT9X accelerometer (ActiGraph, Pensacola, Florida). Minutes per day of MVPA accrued in bouts of at least 10 minutes (referred to as MV10) were also determined from the ActiGraph. Participants wore the accelerometer on their right hip for all waking hours across seven consecutive days at each assessment time point. Wear time had to exceed 10 h/d and contain no excessive counts (>20 000) to be considered valid, with non-wear time defined as at least 60-consecutive minutes of zero counts. Data were processed using 60-second epochs. Daily accelerometer logs were completed by participants to allow for cross-checking of data.

Two thresholds were applied to the data to define PA.

i. Sasaki cut-points were our primary outcome measure since they utilize triaxial data on the basis of three planes of movement (vertical, antero-posterior, and medio-lateral). The Sasaki equation has been validated and demonstrated better accuracy and precision in assessing MVPA among free-living older adults. Sasaki vector magnitude cut-points were sedentary (<674 vmu), moderate (2690-6165 vmu), vigorous (6167+ vmu), and MVPA (2690+ vmu). Bouts of sedentary time for a minimum of 20-consecutive minutes were analysed because of corresponding clinical changes in cardiometabolic biomarkers.

ii. Freedson cut-points rely on uniaxial data (vertical plane) and are the most commonly reported in the field, therefore allowing comparison of our findings to other studies. Freedson cut-points were sedentary (<100 cpm), moderate (1952-5724 cpm), vigorous (5725+ cpm), and MVPA (1952+ cpm). Sedentary behaviour was also considered in 20-minute bouts (<100 cpm).

2.8 | Cardiovascular risk

Blood pressure and BMI indicated modifiable cardiovascular risk factors. Blood pressure was measured twice and averaged using an Omron IC-10 Upper-Arm Monitor (HEM 7070-E). BMI was calculated using participants' weight at each assessment and height measured at T1.

2.9 | Sample size

To detect a small-to-moderate effect (f = 0.17), as identified in similar designs, a group by time interaction for the primary outcome of MVPA with 80% power and an alpha level of 0.05. S6 participants were required (28 per group). We recruited an additional 20% to allow for attrition.

2.10 | Statistical methods

All analyses were performed using SPSS Statistics v24 (SPSS Inc, Chicago, Illinois). Demographic characteristics at baseline are reported for both groups (Table 1). Since MV10 included a large proportion of true zero minutes per week values, models produced a poor fit. MV10 was therefore dichotomized into insufficiently active (<150 min/wk) vs sufficiently active (≥150 min/wk). Other continuous outcomes were inspected to determine appropriate distributions for the generalized linear mixed models (GLMMs). Residual and deviance distributions were visually inspected to ensure they were consistent with the assumption of normality for continuous outcomes. The specific GLMM used to analyse each measure is listed in Data S1. We report the estimated means from the models for continuous measures as these are the best representation of central tendency of the data given the distributions of the outcome variables. Observed means based on the usual assumption of normality, however, are reported in Data S2 for the purpose of comparison with other studies.

All models included the fixed effects group (intervention and control), time (T1 and T2), and group by time interaction, with a random intercept for participant. All models were subsequently adjusted for...
| TABLE 1  Baseline characteristics of participants |
|--------------------------------------------------|
| Overall (n = 68) | Intervention (n = 34) | Control (n = 34) | P Value |
| Age (mean, SD)  | 64.07 (7.94) | 65.26 (7.41) | 62.88 (8.37) | 0.218 |
| Gender           |                   |                   |            |
| Female           | 34 (50%) | 21 (61.8%) | 13 (38.2%) | 0.069 |
| Marital status   |                   |                   |            |
| Married/In a relationship | 52 (76.4%) | 25 (73.5%) | 27 (79.4%) | 0.359 |
| Divorced/Separated | 9 (13.2%) | 6 (17.6%) | 3 (8.8%) |
| Single           | 6 (8.8%) | 2 (5.9%) | 4 (11.8%) |
| Widowed          | 1 (1.5%) | 1 (2.9%) | 0 |
| Education        |                   |                   |            |
| University degree| 33 (48.5%) | 17 (50%) | 16 (47.1%) | 0.670 |
| Post-school training | 17 (25%) | 9 (26.5%) | 8 (23.5%) |
| High school      | 18 (26.5%) | 8 (23.5%) | 10 (29.4%) |
| Ethnicity        |                   |                   | 1.000 |
| Caucasian        | 66 (97.1%) | 33 (97.1%) | 33 (97.1%) |
| Indian           | 2 (2.9%) | 1 (2.9%) | 1 (2.9%) |
| Household income (AUD) |                   |                   | 0.339 |
| ≤$30 000        | 7 (10.3%) | 5 (14.7%) | 2 (5.9%) |
| $30 001-$52 000 | 18 (26.5%) | 11 (32.4%) | 7 (20.6%) |
| $52 001-$104 000 | 20 (29.4%) | 7 (20.6%) | 13 (38.2%) |
| $104 001-$156 000 | 13 (19.1%) | 6 (17.6%) | 7 (20.6%) |
| ≥$156 001       | 9 (13.3%) | 4 (11.7%) | 5 (14.7%) |
| Missing          | 1 (1.5%) | 1 (2.9%) | 0 |
| Smoking status   |                   |                   | 0.562 |
| Non-smoker       | 55 (80.9%) | 26 (76.5%) | 29 (85.3%) |
| Ex-smoker        | 11 (16.2%) | 7 (20.6%) | 4 (11.8%) |
| Current smoker   | 2 (2.9%) | 1 (2.9%) | 1 (2.9%) |
| Comorbidities    |                   |                   |            |
| Overweight       | 25 (36.8%) | 12 (35.3%) | 13 (38.2%) | 0.582 |
| Obese            | 24 (35.3%) | 14 (41.2%) | 10 (29.4%) | 0.318 |
| Hypertensive     | 49 (72.1%) | 25 (73.5%) | 24 (70.6%) | 0.787 |
| Hypercholesterolemic | 15 (22.1%) | 8 (23.5%) | 7 (20.6%) | 0.770 |
| Diabetic         | 9 (13.2%) | 3 (8.8%) | 6 (17.6%) | 0.283 |
| Insufficiently active | 60 (88.2%) | 32 (94.1%) | 28 (82.4%) | 0.215 |
| Cancer type      |                   |                   | 0.042^ |
| Colorectal       | 53 (77.9%) | 23 (67.6%) | 30 (88.2%) |
| Gynaecologic     | 15 (22.1%) | 11 (32.4%) | 4 (11.8%) |
| Treatment        |                   |                   | 0.760 |
| Surgery only     | 35 (51.5%) | 16 (47.1%) | 19 (55.9%) |
| Surgery with chemotherapy | 17 (25%) | 11 (32.4%) | 6 (17.6%) |
| Surgery with radiation therapy | 2 (2.9%) | 2 (5.9%) | 0 |
| Surgery with chemotherapy and radiation therapy | 14 (20.6%) | 5 (14.7%) | 9 (26.5%) |
| Body mass index (mean, SD) | 28.26 (4.95) | 28.86 (4.93) | 27.66 (4.96) | 0.322 |

^Cancer type differed between groups, P < 0.05. Hypertensive: ≥140/90 mm Hg or taking antihypertensive medication. Hypercholesterolemic: total cholesterol > 5.2 mmol/L or taking antihypercholesterolemic medication. Insufficiently active: completing < 150 min/wk of MVPA in bouts of ≥10 min.
minutes of accelerometer wear, age, gender, and cancer type, but these factors did not alter the results.

We performed sensitivity analyses only including participants who had specific cardiovascular risk factors (Data S3) and excluding seven participants who did not adhere to the assigned condition (Data S4). The data that support the findings of this study are available from the corresponding author upon reasonable request.

3 | RESULTS

Figure 1 displays the flow of randomized participants to intervention (n = 34) and control (n = 34) groups. Nonresponse bias analyses revealed no significant differences across age, American Society of Anesthesiologists (ASA) score, BMI, cancer grade, gender, surgeon, hospital site, cancer type, or adjuvant therapies between responders and nonresponders to the invitation letter. Responders had a shorter follow-up time since diagnosis (2.2 vs 2.9 y) compared with nonresponders (t_{276} = 3.22, P < 0.05).

Demographic characteristics were similar across groups at baseline, except that the intervention arm contained more endometrial survivors (Table 1). Sixty-four participants (94%) completed the 12-week assessment. Intervention adherence was excellent, with 94% attendance across group sessions. Most participants (88%, n = 29) in the intervention group accepted the Fitbit friend request. Fitbit engagement was high with 86% (SD = 29) of valid wear-days over the 12 weeks (n = 28). A step count of ≥1000 steps per day was defined as a valid wear-day. Three participants did not appear to engage with their Fitbit beyond week 4, and one experienced syncing errors. Mean daily steps across the intervention are reported in Figure 2, with steps ranging from 8233/d in week 2 to 10 318/d in week 12 (mean = 9217, SD = 705). Despite all participants reporting as insufficiently active

![FIGURE 1](consort_diagram.png)
during phone screening, eight participants completed ≥150 min/wk of MV10 at baseline, according to uniaxial estimates. These participants have been included for the purposes of intention-to-treat analyses.

3.1 | Intention-to-treat analyses

3.1.1 | Activity measures

Intention-to-treat analyses identified a significant increase of 45 minutes in MVPA per week in the intervention group compared with a reduction of 21 min/wk in the control group (\(F_{1,126} = 5.14, P = 0.025\)) using triaxial estimates. Table 2 demonstrates that uniaxial estimates are consistently lower than triaxial estimates (+16 vs -20 min/wk in the intervention and control groups, respectively; \(F_{1,127} = 2.29, P = 0.133\)). The group by time interaction for the dichotomized MV10 was nonsignificant (Table 2). However, the observed mean increases in MV10 were higher in the intervention group vs controls on both triaxial (29 vs 8 min/wk) and uniaxial (31 vs 7 min/wk) measures of MVPA accumulated in bouts of at least 10 minutes. Sedentary time decreased significantly from T1 to T2 by 2.94 and 2.61 h/wk for the intervention and control groups, respectively (\(F_{1,126} = 10.04, P < 0.01\)). Sedentary behaviour in ≥20-minute bouts decreased for both groups (\(F_{1,127} = 13.61, P < 0.001\)). Group × time interactions were nonsignificant (Table 2).

3.1.2 | Cardiovascular risk outcomes

Systolic blood pressure (SBP) (\(F_{1,128} = 17.36, P < 0.001\)), diastolic blood pressure (DBP) (\(F_{1,128} = 4.43, P < 0.05\)), and BMI (\(F_{1,128} = 35.31, P < 0.01\)) improved significantly over time across both groups. Group by time interactions for these three outcomes were nonsignificant (Table 2); however, the reduction in SBP and DBP for the intervention group was more than twice that of the control group (-14 vs -6 mm Hg, respectively, for SBP and -5 vs -1 mm Hg for DBP). For participants with DBP of ≥90 mm Hg at baseline (n = 36), there was a significant group by time interaction (\(F_{1,66} = 4.89, P = 0.031\)) with a net reduction of 9.89 mm Hg in the intervention group. Reductions in SBP in those with hypertension (n = 47 ≥140/90 mm Hg) were not significantly different between the intervention and control groups, respectively (-17 vs -9 mm Hg) (Data S3).

3.2 | Sensitivity analyses

Excluding seven participants due to nonadherence (Data S4) resulted in significant interactions on MVPA for triaxial (\(F_{1,112} = 14.93, P < 0.001\)) and uniaxial (\(F_{1,113} = 8.96, P = 0.003\)) estimates with net increases of 103 and 64 minutes respectively in favour of the intervention. MV10 yielded a significant group by time interaction on uniaxial estimates (\(F_{1,113} = 4.30, P = 0.040\)), with six participants becoming sufficiently active in the intervention group, compared with two in controls at T2.

4 | DISCUSSION

Our trial is one of the first to utilize wearables in combination with action planning and goal setting to increase PA in cancer survivors. Intention-to-treat analyses revealed a significant between group net difference of 66 min/wk of MVPA favouring the intervention group (45-min increase at 12 wk). Sedentary behaviour reduced significantly by approximately 3 h/wk for both groups. This reduction remained when examining bouts of ≥20 min for both groups. This reduction may prompt less sedentary behaviour. Given that replacing 1 hour of sedentary time per day with an equal amount of...
### TABLE 2  Estimated means for physical activity and cardiovascular risk factors

#### All Participants (n = 67)

|                   | Baseline | 12 wk | Intervention (Mean and CIs) | Control (Mean and CIs) | Intervention Change (Mean and CIs) | Mean Control Change (Mean and CIs) | Group × Time | P      |
|-------------------|----------|-------|----------------------------|------------------------|-----------------------------------|-----------------------------------|-------------|--------|
|                   |          |       | Intervention               | Control                |                     |                                   | F1,126      | 0.025* |
| **Triaxial estimates** |          |       |                            |                        |                                   |                                   |             |        |
| MVPA, min/wk      | 267 (207, 344) | 261 (202, 337) | 312 (242, 402) | 240 (185, 311) | +45 (2, 88) | -21 (-59, 17) | 5.14 | 0.025* |
| Moderate PA, min/wk | 254 (198, 325) | 247 (192, 317) | 295 (230, 379) | 217 (168, 280) | +41 (0, 83) | -29 (-65, 7) | 6.77 | 0.010* |
| Sedentary time, h/wk | 72 (68, 75) | 72 (68, 75) | 69 (66, 72) | 69 (65, 72) | -3 (-5, -1) | -3 (-5, 0) | 0.04 | 0.851  |
| MV10 (completing ≥150 min/wk) | n = 6 (18%) | n = 5 (15%) | n = 9 (27%) | n = 7 (21%) | n = +3 | n = +2 | 0.00 | 0.989  |

|                   |          |       | Intervention (Mean and CIs) | Control (Mean and CIs) | Intervention Change (Mean and CIs) | Mean Control Change (Mean and CIs) | Group × Time | P      |
|-------------------|----------|-------|----------------------------|------------------------|-----------------------------------|-----------------------------------|-------------|--------|
| **Uniaxial estimates** |          |       |                            |                        |                                   |                                   | F1,127      |        |
| MVPA, min/wk      | 170 (128, 225) | 158 (119, 211) | 186 (140, 247) | 138 (103, 185) | +16 (-21, 53) | -20 (-52, 12) | 2.29 | 0.133  |
| Moderate PA, min/wk | 164 (125, 216) | 152 (115, 201) | 178 (135, 235) | 127 (96, 168) | +14 (-21, 50) | -25 (-56, 5) | 3.13 | 0.079  |
| Sedentary time, h/wk | 64 (60, 67) | 64 (60, 67) | 61 (57, 64) | 60 (57, 64) | -3 (-5, 0) | -4 (-6, -1) | 0.13 | 0.717  |
| Sedentary ≥20-min bouts, h/wk | 27 (23, 31) | 28 (24, 32) | 23 (19, 27) | 24 (20, 28) | -4 (-7, -1) | -4 (-8, -1) | 0.09 | 0.767  |
| MV10 (completing ≥150 min/wk) | n = 2 (6%) | n = 5 (15%) | n = 8 (24%) | n = 6 (18%) | n = +6 | n = +1 | 1.66 | 0.199  |

|                   |          |       | Intervention (Mean and CIs) | Control (Mean and CIs) | Intervention Change (Mean and CIs) | Mean Control Change (Mean and CIs) | Group × Time | P      |
|-------------------|----------|-------|----------------------------|------------------------|-----------------------------------|-----------------------------------|-------------|--------|
| **Cardiovascular risk factors** |          |       |                            |                        |                                   |                                   | F1,128      |        |
| Body mass index, kg/m² | 28.86 (27.17, 30.54) | 27.66 (25.98, 29.34) | 28.41 (26.73, 30.10) | 27.19 (25.51, 28.87) | -0.44 (-0.65, -0.23) | -0.47 (-0.69, -0.25) | 0.04 | 0.848  |
| Systolic blood pressure, mm Hg | 145.15 (138.96, 151.33) | 139.82 (133.64, 146.01) | 131.34 (125.08, 137.60) | 133.63 (127.21, 140.05) | -13.80 (-20.44, -7.17) | -6.19 (-12.98, 0.60) | 2.52 | 0.115  |
| Diastolic blood pressure, mm Hg | 88.00 (83.99, 92.01) | 84.15 (80.14, 88.15) | 82.60 (78.55, 86.66) | 82.96 (78.80, 87.12) | -5.40 (-9.73, -1.07) | -1.19 (-5.62, 3.24) | 1.81 | 0.181  |

*Note. Means are predicted from the models accounting for clustering between participants. N(%) are reported for binary logistic regression analyses on MV10.*
activity is associated with reduced all-cause mortality in older adults completing little activity,\textsuperscript{24} further investigation of strategies for reducing sedentary behaviour is warranted.

For those classified as hypertensive for DBP, there was a significant reduction in the intervention group of 9.77 mm Hg compared with controls and a trend towards reduction for SBP. Our findings are substantial given the effects of previous PA interventions on blood pressure.\textsuperscript{35} However, our findings are consistent with a review on walking interventions on blood pressure control that reported mean changes ranging from −5.2 to −11 mm Hg for SBP and −3.8 to −7.7 mm Hg for DBP.\textsuperscript{36}

Previous PA interventions for survivors have typically demonstrated small-to-moderate effect sizes.\textsuperscript{37} The WATAAP trial yielded promising findings when compared with similar designs with net changes of 24 and 33 min/wk of self-reported MVPA respectively.\textsuperscript{38,39} A similar low-intensity intervention produced an increase of 18 min/wk of MVPA following a Fitbit intervention for overweight and obese adults.\textsuperscript{40} Further, a 10-week wearable device and social media–based intervention yielded an increase of 25-minute MVPA per week in breast cancer survivors.\textsuperscript{25} The considerable increase of 45 min/wk of MVPA observed in our intervention is almost double that of most previous studies\textsuperscript{25,37,40} and may be because of the evidence-based BCTs that are now incorporated into smart-tracker technology including self-monitoring, goal setting, and behavioural feedback. A recent higher-intensity Fitbit intervention with breast cancer survivors supports this finding, demonstrating a 103 min/wk net improvement in MVPA.\textsuperscript{24} Fitbit engagement was high throughout the intervention (86%) displaying promise for low-intensity interventions.

5 | CONCLUSIONS

5.1 | Study limitations

Limitations include a relatively brief intervention with a small sample of primarily female Caucasian survivors from private hospitals in Perth, Western Australia. Our findings concerning blood pressure should be interpreted with caution, since we did not assess medication change. Despite the significant increase in MVPA, the change in proportion of participants meeting the guidelines in relation to MV10 did not significantly differ by group. Future research would do well to promote more deliberate and continuous bouts of MVPA in accordance with the guidelines. Our sample may be subject to a participation bias, as it is likely that we have recruited a particularly motivated cohort. Including survivors of other cancers and public hospitals may improve the external validity of our findings.

5.2 | Clinical implications

The WATAAP intervention yielded a clinically meaningful increase in MVPA and reduction in DBP among intervention participants that were hypertensive (DBP ≥ 90 mm Hg), displaying promise for the use of low-intensity interventions using smart wearables. BMI and SBP also improved but not significantly between the groups. Investigation of the extended-term efficacy of wearables for PA maintenance and reduced sedentary behaviour is essential. Future work could examine the active ingredients of the intervention and explore the support needs required for prolonged engagement with smart wearables and long-term exercise adherence.

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CONFLICT OF INTEREST

None.

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SUPPORTING INFORMATION

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