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reported. The results of the present study do not constitute endorsement by the American College of Sports Medicine. The results of the study are presented clearly, honestly, and without fabrication, falsification, or inappropriate data manipulation.
Abstract

**Purpose** The randomized controlled trial REACT (NCT03320746) examined the effect of a 12-month consumer-based activity tracker intervention on accelerometer-measured physical activity among recent retirees.

**Methods** Altogether 231 recently retired Finnish adults (mean age 65.2 years (SD 1.1), 83% women) were randomized to intervention and control groups. Intervention participants were requested to wear a commercial wrist-worn activity tracker (Polar Loop 2, Polar, Kempele, Finland) for 12 months, to try to reach the daily activity goals shown on the tracker display, and to upload their activity data to a web-based program every week. The control group received no intervention. Accelerometer-based outcome measurements of daily total, light (LPA) and moderate-to-vigorous (MVPA) physical activity were conducted at baseline and at 3-, 6-, and 12-month time points. Hierarchical linear mixed models were used to examine the differences between the groups over time. All analyses were performed by intention-to-treat principle and adjusted for wake wear time.

**Results** The use of a commercial activity tracker did not increase daily total activity, LPA or MVPA over the 12 months’ period when compared to non-user controls (group*time interaction p 0.39, 0.23, and 0.77, respectively). There was an increase in LPA over the first six months both in the intervention (26 min/day, 95% CI 13 to 39) and control (14 min/day, 95% CI 1 to 27) groups, but the difference between the groups was not significant (12 min/day, 95% CI -6 to 30). In both groups, LPA decreased from 6 to 12 months.
Conclusion The 12-month use of a commercial activity tracker does not appear to elicit significant changes in the daily total activity among a general population sample of recent retirees, thus highlighting the need to explore other alternatives to increase physical activity in this target group.

Keywords physical activity, RCT, wearable technology, retirement, older adults
INTRODUCTION

The number of retired adults is increasing worldwide. Strategies to support retirees to be more physically active in their daily lives are important for the maintenance of health and mobility with advancing age (1). Among other life transitions and events, retirement can be regarded as an opportunity for individuals to change their physical activity behavior along with the increased time available and restructured leisure activities, which may facilitate physical activity (2–4). Observational follow-up studies have shown that self-reported leisure-time physical activity increases during the retirement transition (5–8), but so does also self-reported sitting time (8–11). More recent accelerometer-based studies have found that women decrease their daily total activity (12) whereas men remain highly sedentary (13) after retirement transition. Therefore, retirement appears to be an important, and perhaps the most optimal time point to intervene, either to maintain or promote physical activity at older age (11, 14, 15). However, according to the literature, there are only few studies on physical activity interventions targeted to recently retired adults (16–19), thus, the potential of this time period is not fully explored.

Traditional physical activity interventions, such as group or individual counselling and training sessions, are reported to be effective in improving physical activity levels up to 12 months in older adults, but the evidence relies mostly on subjectively measured outcomes (16, 20). Unlike face-to-face interventions requiring facilities and time, various e-health interventions, such as web- or mobile-based interventions, are more scalable and accessible to promote physical activity, and also feasible as technology can be harnessed to deliver behavioral change techniques (21). Overall, e-health interventions have shown to be acceptable for older population and effective in increasing physical activity up to 6 months in adults over 60 years of age (18,
Previous multicomponent e-health interventions have used wearable devices, such as pedometers and accelerometers, as a supplement to other intervention components or to measure the outcomes (24–26). Commercially available activity or fitness trackers (e.g., Fitbit) are increasingly used as the core instruments of technology-aided interventions (27) as they offer evidence-based self-management strategies, such as goal setting and feedback (28). However, previous consumer-based activity tracker interventions with accelerometer-measured physical activity as an outcome have been of short duration (3 to 6 months) (21, 27) and only a few studies have been conducted among adults over 60 years of age (24). A web-based intervention (Philips DirectLife), including an accelerometer-based activity monitor, a personal website and an e-coach, increased moderate-to-vigorous physical activity (MVPA) by 11 min/day in 12 weeks among inactive 60 to 70 years old adults (29). A Fitbit-based intervention increased weekly MVPA by 62 minutes in 16 weeks among inactive postmenopausal women (30). Also, the use of the Jawbone Up24 wearable activity monitor and app, including weekly phone calls during the intervention, increased daily activity in 12 weeks among sedentary 60 years old adults (31). Furthermore, there are other multicomponent physical activity interventions that have found that utilizing commercial activity trackers among older adults benefits a physical activity intervention (32, 33). However, the independent and long-term (>6 months) effect of commercial activity tracker on daily total physical activity among older adults has not yet been studied.

The primary aim of the Enhancing physical ACTivity and healthy aging among recent REtirees (REACT) trial was to evaluate the effect of a 12-month consumer-based activity tracker
intervention, as compared to controls not using any activity trackers, on accelerometer-measured
daily total physical activity, light physical activity (LPA), and MVPA in recently retired Finnish
adults. The hypothesis was that daily total activity increases to a significantly greater extent
within the intervention group than within the control group.

METHODS

Participants

Recruitment of the participants

The target group for the REACT trial included Finnish public sector employees whose estimated
statutory retirement dates were between January 2016 and April 2019 and who lived in the
region of Southwest Finland in 2017. The information on the estimated individual statutory
retirement dates was obtained from the pension insurance institute for the municipal sector in
Finland (Keva). The number of eligible individuals was 1,475 (1,166 women, 309 men), and
they were first contacted with a letter mailed to their home addresses in January 2018. The letter
included detailed information of the REACT trial, the inclusion criteria, and a link to a short
web-based questionnaire, which aimed at collecting data on the demographic characteristics,
current health status, the actual dates of retirement, and e-mail addresses for those who got
interested. The enrollment continued to March 2018.

The inclusion criteria for the REACT trial were the following: self-reported actual date of
retirement between January 2016 and December 2018, self-reported ability to walk 500 m
without interruption, no current post-operative state, no known surgery within the next 6 months,
no malign cancer or recent myocardial infraction, basic knowledge on how to use a computer,
and Internet access at home. In Finland, it is possible to continue working after statutory retirement, and an irregular or part time job was not used as an exclusion criterion.

Overall 272 individuals (18.4% of those eligible) expressed their interest to take part in the study. The respondents were more frequently women (82% vs. 78%) and highly educated (37% vs. 20%) compared to non-respondents (n=1,203). There was no difference in the mean age (65.1 (SD 1.2) vs. 64.9 (SD 1.3) years). Of the respondents, 252 individuals were invited to the study as we did not include individuals who had retired before January 2016 (n=12) or individuals who reported they will retire after the year of 2018 (n=8). Finally, 231 recent retirees were able to participate and 21 were not. Figure 1 presents the flow diagram of participation. Baseline measurements were conducted on average 1.2 (SD 0.6) years after the actual date of retirement.

**Randomization**

After the baseline measurements, all participants were randomized into two groups with an allocation ratio of 1:1. A statistician not involved in the running of the REACT trial prepared the randomization lists stratified by gender and using a random permuted block method with SAS software. The randomization slips were sealed in opaque envelopes in a numerical order. The envelopes were opened for each participant in the order of their clinical visits by a researcher. After the randomization, the initialized activity trackers, along with detailed instructions on how to use them and the manufacturer’s web-based program/application, were mailed to the intervention group members. The control group members were informed of their allocation by e-mail.
**Power calculation**

The power calculation was based on a previous finding of an increase of 11% (SD 31) in the wrist-worn accelerometer activity counts among 60 to 70 years old adults after using a commercial activity monitor and web-based physical activity program for 3 months (29). We aimed to detect a 12%-unit difference in daily total activity between the intervention and control groups (assuming a 12% mean change in the intervention group and no mean change in the control group) after 12 months. Based on a power of 0.80 and 2-sided alpha of 0.05, the required sample size for the REACT trial was 214 participants. By taking into account a dropout rate of 10%, 240 participants was the goal set for the recruitment.

**Ethics**

The study follows the guidelines of good scientific practice set by the National Advisory Board on Research Ethics in Finland and the Declaration of Helsinki. The REACT trial has been approved by the ethics committee of the Hospital District of Southwest Finland (107/1801/2017) and its ClinicalTrials.gov registration number is NCT03320746. All participants were informed of the study protocol and voluntariness before they expressed their willingness to participate and gave a signed, informed consent.

**Intervention**

The participants randomized to the intervention group were requested to wear a commercial wrist-worn activity tracker (Polar Loop 2, Polar, Kempele, Finland) on their non-dominant wrist every day and night for 12 months. The Polar Loop 2 activity tracker included multiple behavior change techniques, such as goal setting, self-monitoring, and feedback, which are evidence-
based self-management strategies (28) and comparable to those in other commercial activity trackers (34). As several features of the Polar Loop 2 were built around the daily activity goal, the daily activity goal attainment was chosen as the behavioral target for the intervention in order to maintain concordance between the goals and the means of the intervention. No further counselling or guidance on how to achieve the daily activity goal was given to the participants.

The participants were instructed to pursue the daily activity goal, initially set at Stage 1 as per the goals set by the tracker manufacturer. The pre-set stages in activity goals were built around user’s typical daily activities and they were also sensitive to the user’s gender and age. Since the Polar Loop 2 is tracking activity with a built-in accelerometer, various kinds of activities contribute to the achieving of the daily activity goal: activities at higher intensities helped to reach the daily goal faster than activities at lower intensities. The achievement of 100% of the daily activity goal at Stage 1 corresponded for example to 57 minutes of jogging, or 2 h 11 min of walking, or 7 h 20 min of household chores, or, a combination of activities at different intensities. At Stage 1, the amount of daily activity necessary to achieve the goal exceeded the recommendation of weekly 150 minutes of MVPA (35).

The activity tracker enabled the user to monitor real-time achievement of the activity goal and, e.g., the accumulation of daily steps. Based on the accumulated daily activity, the tracker provided feedback and displayed practical guidance on how to reach the remaining part of the daily goal, e.g., “jog for 20 minutes” or “walk for 50 minutes”. Upon 100% fulfillment of the daily goal, the tracker congratulated the user. Participants who frequently achieved or exceeded 100% of their daily activity goals at Stage 1, were suggested by the researcher, via e-mail or sms,
to move on to Stage 2 (activity goal comparable to ~3 h/day of walking), and ultimately Stage 3 (activity goal comparable to ~3.5 h/day of walking). In some cases, the users changed the stage by themselves. The tracker also gave an inactivity alert by vibrating after 55 minutes of a non-movement period, coupled with a prompt “it's time to move” shown on the display. (See Table, Supplemental Digital Content 1, Intervention content described in terms of behavior change techniques for details of the intervention content.)

A researcher created personal accounts for the participants in Polar’s web-based program (Polar Flow), to which the participants were requested to upload their activity tracker data at least once a week. The participants had unrestricted access to their personal Polar Flow accounts using a computer or mobile phone app. The uploading of the data from the tracker with a computer required the opening of Polar Flow in a web browser. Polar Flow displayed overviews and summaries of the activity data on a daily, weekly and monthly basis. Polar Flow also provided feedback on the attainment of the daily activity goal, and if the tracker had been worn sufficiently, a detailed feedback on the health benefits of accumulated activity, sedentary time, and sleep on daily, weekly and monthly levels (See Figure, Supplemental Digital Content 2, Polar Flow diary view). The information from Polar Flow enabled researchers to follow the monthly use of the trackers, and if any lack of data was observed, the participant was contacted and requested to synchronize activity data from the tracker to Polar Flow. The activity data obtained from Polar Flow was also used to follow the achievement of the daily activity goal and to evaluate the dose of activity.

The control group members were requested to abstain from the use of any type of activity
trackers during the 12-month follow-up period and they were informed that they will receive Polar Loop 2 activity trackers and guidance for using them after the follow-up.

**Measurements**

*Accelerometer measured physical activity*

Wake-time physical activity was measured with wrist-worn tri-axial ActiGraph wGT3X-BT accelerometers at 80 Hz sample frequency. The participants were requested to wear the accelerometers on their non-dominant wrists. Accelerometer measurements lasting eight days and seven nights were conducted at baseline, and at 3-month, 6-month, and 12-month follow-up time points for all the study participants. During the measurement weeks, the participants were also requested to fill in daily logs to indicate in-bed and out-bed times. Accelerometer data were collected between February 2018 and January 2020. Participants were treated in five waves, with the follow-up starting at spring season (44%), autumn season (25%), and winter season (31%). The intervention participants worn both devices, the Polar Loop 2 and the ActiGraph accelerometer, on their non-dominant wrists during the follow-up measurement weeks. The ActiGraph accelerometer was always worn more distally and the Polar activity tracker more proximally on the wrist. Only if a participant reported discomfort while wearing of these two devices on the same wrist, the participant was instructed to wear the activity tracker on his/her dominant wrist and keep using the ActiGraph accelerometer on the non-dominant wrist.

The accelerometer data were analyzed according to a pre-specified data reduction and analysis plan and blinded for the allocation of the participants. Data from the ActiGraph accelerometers were downloaded using the ActiLife software (ActiGraph, Pensacola, Florida, US) and processed
using the open source R-package GGIR (R Foundation for Statistical Computing, Vienna, Austria, [https://cran.r-project.org/]). The GGIR package has been developed for the purpose of processing raw acceleration data from wrist-worn accelerometers into physical activity and sleep variables (36). Non-wear time was detected as a part of the GGIR processing (37), and sleep time was estimated based on the method of van Hees and co-authors (38), using both in-bed and out-bed times in the daily logs and algorithm of the GGIR package. Sleep and non-wear time were then excluded from the analysis. Wake-time total physical activity was determined as the sum of the time spent in LPA and MVPA, using the previously proposed threshold values: ≥30.0 mg for LPA and ≥100.6 mg for MVPA (39, 40). At each time point, accelerometer measurements with at least 4 valid days with a minimum of 10 hours of wear time during waking hours were considered valid, resulting to the exclusion of one follow-up measurement from two of the participants. The average number of valid days was 7.5 (range 4 to 9). The means of wake time total activity for each 24 hours of the measurement days were calculated, including only hours with at least 59 minutes of accelerometer recording (~88% of all measurement hours), and then averaged for each hour of the day across all valid days to illustrate daily physical activity patterns.

**Background characteristics**

The main background characteristics (date of birth, gender, and occupation) of the participants were derived from the pension institute’s register. Occupational status was categorized on the basis of the International Standard Classification of Occupations (ISCO) (41) into three groups: “high” including managers and professionals (ISCO classes 1–2), “intermediate” including associate professionals (ISCO classes 3–4), and “low” including manual and service workers.
(ISCO classes 5–9) by the last known occupation preceding the retirement. Body mass index (BMI) was calculated from the measured height and weight during the baseline clinical measurements. Other baseline characteristics were assessed by a web-based questionnaire. Data on chronic conditions (none, 1, or >1) was based on a question “Has your doctor ever told that you have or have had ….” and the following diseases were taken into account: angina pectoris, myocardial infarction, stroke, claudication, osteoarthritis, osteoporosis, sciatica, fibromyalgia, rheumatoid arthritis, depression or other mental illness, and diabetes. Limitations in walking a distance of 2 kilometers (yes vs. no) were evaluated with the Short Form SF-36 (42). Self-reported physical activity was assessed with a question concerning the average weekly duration and intensity of leisure time physical activity during the past 3 months, and expressed as weekly metabolic equivalent (MET) hours.

**Statistical analysis**

Baseline characteristics of the study participants are presented as numbers and percentages for the categorical variables and as means and standard deviations (SDs) for the continuous variables. All analyses were performed by intention-to-treat principle so that all randomized participants were included in the analyses. Hierarchical linear mixed models were used to examine the differences in total physical activity (primary outcome), including LPA and MVPA, and wake wear time between the groups. The model included intervention group as a between-factor, time as a within-factor, and the group by time interaction. For the secondary analyses, we stratified the study participants into tertiles according to the daily total physical activity at baseline: low (47 to 229 min), middle (229 to 318 min), and high (318 to 546 min). We then examined the changes in physical activity by the baseline physical activity tertiles using
hierarchical linear mixed models. Because the group*time interaction was significant for wake wear time (p=0.04, partly due to differences in sleep time between the groups), all analyses were adjusted for wake wear time of the accelerometer. All results are shown as mean estimates and 95% confidence intervals (CIs). The SAS Software 9.4 was used for the statistical analyses (SAS Institute Inc., Cary, NC).

**Results**

The mean age of the 231 randomized participants was 65.2 years (SD 1.1, range 61.8 to 67.6 years), 83% were women, 35% had normal weight, and 38% had high occupational status. The baseline characteristics for the intervention and control group participants are showed in Table 1. The mean monthly active time as derived from the activity trackers remained relatively stable across the 12-month intervention (see Table, Supplemental Digital Content 3, Active time per each intervention month from the Polar Loop 2 activity tracker data).

There was no significant intervention effect in the accelerometer-measured daily total activity (group*time interaction p=0.39), LPA (p=0.23), or MVPA (p=0.77) over the 12 months (Table 2). The intervention group members increased their daily total activity by 24 min/day (95% CI 10 to 38) and LPA by 26 min/day (95% CI 14 to 39) over the first six months, but the difference between the changes of the groups was not significant (11 min/day, 95% CI -9 to 31 for total and 12 min/day, 95% CI -6 to 30 for LPA). Total and LPA levels returned close to the baseline levels in both groups at 12 months (Figure 2). No differences in the change in MVPA over time was observed between the groups. Daily profiles of the means of hourly activity showed that the intervention group had slightly more of total activity from midday to late evening hours at 6
months, but no notable differences were observed in other time points (Figure 3).

There were no differences in the changes in total, LPA, and MVPA between the groups by the baseline activity tertiles over the 12 months (tertile*group*time interaction p-value 0.54, 0.33, and 0.27, respectively). The stratified analysis showed an increase in total physical activity among the lowest activity tertile over the first six months: 67 minutes (95% CI 42 to 93) for the intervention and 52 minutes (95% CI 29 to 74) for the control group, but no difference was observed between the groups (16 min/day, 95% CI -18 to 50) (Figure 4). Similarly, the intervention participants in the lowest activity tertile increased daily LPA from baseline to 6 months by 64 minutes (95% CI 41 to 86) and the control participants in the lowest activity tertile by 46 minutes (95% CI 26 to 66), but no difference was observed between the groups (18 min/day, 95% CI -12 to 48). The total and LPA levels returned to a lower level in both groups at 12 months (Figure 4).

Discussion

The REACT trial is the first consumed-based activity tracker intervention targeted for the time immediately after retirement when people have been found to be prone to increase their physical activity (3, 5–8). The results from our long-term trial showed that the use of a commercial activity tracker did not increase accelerometer-measured daily total physical activity, LPA or MVPA over the 12 months among recent retirees, when compared to controls not using the activity trackers. However, there was an increase in the LPA over the first six months, especially among the participants in the lowest baseline activity tertile, but the change was not significantly different from that of the controls and the levels lowered near to baseline levels in both groups at
the 12-month end point.

The commercial activity tracker used in the REACT trial included self-management strategies, such as goal-setting, self-monitoring, and feedback, which have previously been identified as features of a successful technology-aided intervention among older adults (21, 43) and which are comparable to those of other commercial activity trackers (34). As the purpose of this study was to examine the effect of a low-cost and easily scalable method to promote daily physical activity among recently retired adults, the intervention consisted of the use of the commercial activity tracker and no other methods were included. Consequently, the behavioral target for the intervention was defined in terms of the daily activity goals inherent in the activity tracker. Although the daily activity goal used in this study is not comparable to the previous intervention studies using 150 min/week of MVPA or 10,000 daily steps as the goal, the daily activity goal at Stage 1 already exceeded the recommendations of 150 min/week of MVPA (35).

The results of our study showed that the 12-month use of a commercial activity tracker can induce short-term albeit non-significant changes in LPA among recent retirees. The short-term finding is somewhat comparable to previous multicomponent interventions utilizing wearable devices (29–33) and showing an increase in mainly MVPA up to 6 months among older adults. However, in the previous trials, the physical activity goals were set according to instructions or programs on how to achieve the goal (e.g., 150 minutes of weekly MVPA or 10,000 daily steps). In the REACT trial, the daily activity goal included the possibility to accumulate various activities at different intensities, and no guidance on how to achieve the daily activity goal was given by the researchers. These differences in the intervention aims, durations, and methods
between the present tracker-based and previous multicomponent interventions can explain why we saw no changes in MVPA, but some temporary increase in LPA, especially among the least active participants. However, although the short-term finding favored intervention participants, the changes were not significantly different from those of the control retirees not using the trackers. Therefore, integrated methods, such as counselling (31, 44, 45) or a web-based intervention (29, 32, 33, 46), may be needed to induce more marked changes in physical activity (27).

It is plausible that the daily activity goals in the present study were too easily achieved by some of the intervention members. Among the highly active participants, the activity tracker could have only been used as a monitoring equipment, and more features (e.g., heart rate) might have been needed to increase physical activity (27, 45, 47). Furthermore, our long-term findings, among others (25, 27), showed that the changes in physical activity elicited by the activity trackers may only be temporary. In fact, the overall usage of the wearable devices has been shown to be rather short-term among older adults (47). Therefore, more long-term interventions are needed to examine which integrated or alternative methods are effective in producing long-term changes in physical activity habits in this age group.

Strengths and limitations

The REACT trial has several strengths. The participants were recruited according to their actual dates of retirement, which enabled us to target the intervention to a time-window immediately after retirement. The REACT trial included accelerometer-based outcome measurements at four different follow-up time points over 12 months so as to capture both short- and long-term
changes. The adherence to the outcome measurements among both intervention and control group members was excellent as the dropout rate was only 2%. All analyses were performed by intention-to-treat principle. In addition, we were able to follow and control the individual usage of the trackers and to evaluate the dose of activity among the intervention participants.

There are also limitations that should be acknowledged. First, the wrist-worn accelerometers were selected to measure the whole 24-hour behavior, but they are not accurate to detect, e.g., cycling (48). Therefore, we may not have been able to measure all modes of daily activities. Second, the baseline measurements (e.g., body composition) may have motivated participants to change their physical activity behavior irrespective of their group allocation. Also, the “wear-effect” from the wrist-worn accelerometer devices during the follow-up measurements may have increased physical activity levels among the control group participants although the accelerometers did not give any feedback to the users. Third, the retirees who took part in the study were rather healthy and active older adults. The high proportions of women and highly educated adults in the study are in agreement with the characteristics of public sector employees in Nordic welfare state settings, but they may limit the generalizability of our findings. Finally, it remains to be investigated whether increases in total physical activity, though non-significant but still some 24 minutes per day, are translated to better health marker outcomes, when compared to the participants’ own baseline or the control group.

Conclusions

The use of a commercial activity tracker does not elicit significant changes in daily total physical activity over 12 months among a general population sample of recent retirees. Although the
activity trackers may be feasible in supporting physical activity engagement (27), the findings of this study highlight the need to explore other alternatives or complementary strategies to increase physical activity after retirement.
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FIGURE LEGENDS

Figure 1. Flow diagram of the REACT trial.

Figure 2. The change in total physical activity, LPA, and MVPA during the follow-up for the intervention (solid line) and control (dotted line) groups. Results are expressed as means and 95% CIs based on mixed models.

Figure 3. Daily profiles of the means of hourly total physical activity at each follow-up time point for the intervention (solid line) and control (dotted line) groups. Average values are based on mixed models.

Figure 4. The change in total physical activity (A), LPA (B), and MVPA (C) for the members in the intervention (solid line) and control (dotted line) groups by the baseline activity tertiles. Results are expressed as means and 95% CIs based on mixed models.
SUPPLEMENTAL CONTENT

Supplementary file 1_leskinen MSSE_R2.docx: Intervention content described in terms of behavior change techniques (BCTTv1).

Supplementary file 2_leskinen MSSE.docx: Polar Flow diary view

Supplementary file 3_leskinen MSSE_R1.docx: Active time (min/day) per each intervention month from the Polar Loop 2 activity tracker data
Figure 1

CONSORT 2010 Flow Diagram

Enrollment

Assessed for eligibility (n=272)

Excluded (n=41)
  - Not meeting inclusion criteria (n=20)
  - Declined to participate (n=5)
  - Other reason (n=10)

Randomized (n=231)

Allocation

Allocated to intervention (n=117)
  - Received allocated intervention (n=117)
  - Did not receive allocated intervention (n=0)

Allocated to control (n=114)

Follow-Up

Discontinued intervention (discomfort of the wrist band) (n=4)

Discontinued (ill health) (n=1)

Analysis

Analysed (n=117)

Analysed (n=114)
Figure 2

Changes in physical activity over the 12 months

- Total for the intervention group
- Total for the control group
- LPA for the intervention group
- LPA for the control group
- MVPA for the intervention group
- MVPA for the control group

Minutes/day

Baseline  3 months  6 months  12 months
Figure 3

Total physical activity at baseline
- Intervention group
- Control group

Total physical activity at 3 months
- Intervention group
- Control group

Total physical activity at 6 months
- Intervention group
- Control group

Total physical activity at 12 months
- Intervention group
- Control group
Figure 4
Table 1. Baseline characteristics of the participants in the intervention and control groups.

| Characteristics                          | Intervention (n=117) | Control (n=114) |
|------------------------------------------|----------------------|-----------------|
| Age, mean (SD) years                     | 65.2 (1.0)           | 65.2 (1.1)      |
| Gender                                   |                      |                 |
| Women                                    | 96 (82.0)            | 95 (83.3)       |
| Men                                      | 21 (18.0)            | 19 (16.7)       |
| Occupational status                      |                      |                 |
| High                                     | 47 (40.2)            | 41 (36.0)       |
| Intermediate                              | 35 (29.9)            | 28 (24.5)       |
| Low                                      | 35 (29.9)            | 45 (39.5)       |
| Body mass index                          |                      |                 |
| Under/normal weight                      | 38 (32.5)            | 43 (37.7)       |
| Overweight                               | 43 (36.7)            | 45 (39.5)       |
| Obese                                    | 36 (30.7)            | 26 (22.8)       |
| Chronic conditions                       |                      |                 |
| 0                                        | 36 (30.8)            | 27 (23.9)       |
| 1                                        | 47 (40.2)            | 45 (49.8)       |
| >1                                       | 34 (29.1)            | 41 (36.3)       |
| Limitations in walking 2 km*             |                      |                 |
| No                                       | 109 (93.2)           | 106 (93.8)      |
| Yes                                      | 8 (6.8)              | 7 (6.2)         |
| Self-reported physical activity, MET h/week (SD) | 29.9 (21.8)        | 29.1 (21.8)     |
| Years (SD) from retirement transition    | 1.2 (0.6)            | 1.1 (0.5)       |

SD, standard deviation; MET, metabolic equivalent

*from SF-36
Table 2. Intention to treat analysis of the change in accelerometer measured daily total physical activity, LPA, MVPA and wake wear time from baseline to 3-, 6-, and 12-month time points. Results are presented as means and their 95% CIs based on the mixed models.

| Outcome measure                      | Intervention | Control | P values | Time effect | Group*time interaction |
|--------------------------------------|--------------|---------|----------|-------------|------------------------|
|                                      | n            | Mean    | 95% CI   | n           | Mean                   | CI         |
| **Total physical activity, min/day** |              |         |          |             |                        |            |
| Baseline                             | 117          | 280.8   | 264.1    | 114         | 272.4                  | 255.4      | 289.4 |
| Change from baseline to 3 months     | 113          | 11.5    | -2.7     | 114         | 17.3                   | 3.2        | 31.4  |
| Change from baseline to 6 months     | 113          | 23.9    | 9.7      | 112         | 13.0                   | -1.2       | 27.2  |
| Change from baseline to 12 months    | 113          | -6.0    | -20.1    | 112         | -3.7                   | -17.9      | 10.5  | <.0001 | 0.39  |
| **LPA, min/day**                     |              |         |          |             |                        |            |
| Baseline                             | 222.7        | 209.0   | 236.3    | 222.9       | 209.1                  | 236.7      |
| Change from baseline to 3 months     | 114          | 11.4    | -1.3     | 24.0        | 16.1                   | 3.5        | 28.7  |
| Change from baseline to 6 months     | 26.2         | 13.5    | 38.9     | 14.1        | 1.4                    | 26.8       |
| Change from baseline to 12 months    | -4.3         | -16.9   | 8.2      | -0.4        | -13.0                  | 12.3       | <.0001 | 0.23  |
| **MVPA, min/day**                    |              |         |          |             |                        |            |
| Baseline                             | 58.2         | 52.7    | 63.6     | 49.5        | 44.0                   | 55.0       |
| Change from baseline to 3 months     | 0.03         | -4.3    | 4.3      | 1.2         | -3.1                   | 5.5        |
| Change from baseline to 6 months     | -2.3         | -6.6    | 2.0      | -1.1        | -5.4                   | 3.2        |
| Change from baseline to 12 months    | -1.7         | -6.0    | 2.6      | -3.3        | -7.6                   | 1.0        | 0.16  | 0.77  |
| **Wake wear time, min/day**          |              |         |          |             |                        |            |
| Baseline                             | 930.4        | 920.9   | 939.8    | 932.3       | 922.7                  | 941.8      |
| Change from baseline to 3 months     | 14.6         | 6.1     | 23.2     | 2.1         | -6.5                   | 10.6       |
| Change from baseline to 6 months     | 15.1         | 6.5     | 23.7     | 9.6         | 1.0                    | 18.2       |
| Change from baseline to 12 months    | 2.1          | -6.4    | 10.7     | 6.4         | -2.2                   | 15.0       | 0.0006 | 0.04  |

LPA, light physical activity; MVPA, moderate-to-vigorous physical activity; CI, confidence interval
## Supplementary file 1. Intervention content described in terms of behavior change techniques (BCTTv1).

| [#] Behavior Change Technique (BCTTv1) | Mode of Delivery                  |
|---------------------------------------|-----------------------------------|
|                                       | Activity Tracker (Polar Loop 2)   | Web-based Software/Application (Polar Flow)** |
| [12.5] Adding objects to the environment | The intervention group were given activity trackers and requested to wear them every day and night for 12 months. | |
| [1.1] Goal Setting (behavior)         | Participants in the intervention group were instructed to try to reach the daily activity goal, initially set at Stage 1 according to the goals set by the tracker manufacturer. The daily activity goals were based on user’s typical daily activities, and they were sensitive to the user’s gender and age. |
|                                       | The manufacturer’s web-based program/application recommended Stage 1 for individuals whose days included only a little physical activity and a lot of sitting, Stage 2 for individuals who spent most of their days on their feet due to the type of work or daily chores, and, Stage 3 for individuals whose work was physically demanding or who tended to be on the move and highly physically active. |
|                                       | Examples of the amount of physical activity necessary for meeting the set goals:  |
|                                       | Stage 1: 57min of jogging OR 2h 11min of walking OR 7h 20min of household chores OR a combination of activities at different intensities. |
|                                       | Stage 2: 1h 13min of jogging OR 2h 47min of walking OR 9h 20min of household activities OR a combination of activities at different intensities. |
|                                       | Stage 3: 1h 29min of jogging OR 3h 23min of walking OR 11h 20min of household chores OR a combination of activities at different intensities. |
| [1.5] Review behavioral goals         | If a participant frequently exceeded the daily activity goal, a higher goal was suggested by the researcher via e-mail. |
| [1.6] Discrepancy between current behavior and goal | Based on the current level of attained daily activity, the activity tracker displayed how much activity is still required for reaching the daily goal (e.g., “To go: jog for 20 minutes or walk for 50 minutes or up for 2h 30 minutes”). |
| [2.3] Self-monitoring of behavior    | The activity tracker enabled the participant to monitor the | Personal accounts were created by the researcher in |
| **[2.2] Feedback on behavior** | The activity tracker displayed real-time feedback on the level of attainment of the daily activity goal. | Polar Flow where the participants were instructed to upload data from their trackers at least once a week. By presenting overviews and summaries on a daily, weekly and monthly level, Polar Flow allowed for long-term monitoring of the data collected by the tracker (activity, sedentariness, sleep). The participants had unrestricted access to their Polar Flow accounts and, upon uploading the data from the activity tracker, the diary view of the Polar Flow was opened in the web browser (see Supplementary file 2). |
| --- | --- | --- |
| **[7.1] Prompts/Cues** | After 55min of uninterrupted sedentary time, the activity tracker gave an inactivity alert by vibrating and showing a prompt “It’s time to move” on the display. | If the participant failed to respond to the inactivity alert within 5 minutes, an “inactivity stamp” was recorded in Polar Flow and presented in the diary view ([2.3] Self-monitoring of behavior). |
| **[10.4] Social rewards** | The activity tracker informed and congratulated the user upon successful attainment of the daily activity goal. | If worn sufficiently, Polar Flow provided verbal feedback and praise on accumulated activity on a daily, weekly, or monthly level. For wear time requirements, see above ([2.2] Feedback on behavior). |
| **[5.1] Information about health consequences** | If worn sufficiently, Polar Flow presented detailed information about health consequences of accumulated activity. For wear time requirements, see above ([2.2] Feedback on behavior). | *The activity tracker also displayed daily consumption of calories if the user had provided height and weight information in Polar Flow. **Polar Flow contained several additional functionalities, such as provision of training programs, possibilities for using various social media utilities, recording of behavioral and emotional outcomes, and provision of monthly reports of the data collected by the tracker (including a list of “best days” on various measures). However, as the participants were not instructed to use nor informed about these functionalities, they were not coded here as active intervention components.* |
Supplementary file 2. Polar Flow diary view (no patient data, published with permission from Polar).
Supplementary file 3. Active time (min/day) per each intervention month from the Polar Loop 2 activity tracker data. Values are expressed as means and 95% CIs based on mixed models.

Participants were treated in five waves starting the 12-month intervention at spring season (44% of the participants), autumn season (25%) and winter season (31%). Overall, 55% of the participants kept the initial daily activity goal throughout the intervention.