Musculoskeletal Care. Author manuscript; available in PMC 2022 March 01.

Published in final edited form as:
Musculoskeletal Care. 2021 March ; 19(1): 142–145. doi:10.1002/msc.1517.

Does a Physical Therapist-Administered Physical Activity Intervention Reduce Sedentary Time after Total Knee Replacement: An Exploratory Study?

Grace Coleman, BS[1], **Daniel K. White, PT, ScD, MSc**[1], **Louise Thoma, PT, PhD**[2], **Dana Voinier, DPT**[1,3], **Meredith Christiansen, PT, PhD**[1,3], **Laura Schmitt, DPT**[1], **Jason Jakiela, MS**[2], **Hiral Master, PT, PhD, MPH**[1,3,4]

[1]Department of Physical Therapy, College of Health Sciences, University of Delaware

[2]Division of Physical Therapy, University of North Carolina at Chapel Hill

[3]Biomechanics and Movement Science Interdisciplinary Program, University of Delaware

[4]Department of Orthopaedic Surgery, Vanderbilt University Medical Center

Abstract

Design: Exploratory secondary data analysis of a pilot randomized control trial conducted between 2015 and 2017.

Setting: Outpatient physical therapy clinic in an academic setting.

Participants: 43 participants were randomized to the intervention or control group. Both groups received standard physical therapy (PT) after total knee replacement (TKR).

Interventions: Participants in the intervention group received a Fitbit, weekly step goals from their physical therapist, and up to six monthly phone calls after their discharge from PT (DC).

Main Outcome Measures: The outcome, change in sedentary time (ΔSED), was measured using a triaxial accelerometer (Actigraph GT3X) from initial evaluation (IE) to DC (short-term), and IE to 12 months (12M) after DC (long-term). Positive values represent a reduction in SED. We compared the short- and long-term ΔSED between the intervention and control groups using independent t-tests.

Results: Of the 43 participants [mean(SD) age 67.0 (7.0) years, BMI 31.5 (5.9) kg/m^2, 53% female], 36 participants had data at IE and DC (18 intervention, 18 control) and 27 had data at IE and 12M (12 intervention, 15 control). The between group difference in short-term ΔSED was [mean(95%CI)] 32.9 (−14.4, 80.1) minutes/day. The between group difference in long-term ΔSED was 59.2 (8.6, 109.7) minutes/day.

Corresponding author: Hiral Master, PT, PhD, MPH, Vanderbilt University Medical Center, 2525 West End Ave, Suite 1200 Nashville, TN 37203, hiral@udel.edu or hiral.master@vumc.org.

ClinicalTrials.gov **identifier:** NCT02724137.

Ethics: The study has Institutional Review Board approval from the University of Delaware. All participants provided written informed consent before enrollment in the study.

Conflicts of interests: The authors report no conflicts of interests.

Author Manuscript
Author Manuscript
Author Manuscript

Conclusion: Our preliminary results indicate that a physical therapist-administered physical activity intervention may reduce SED in adults after TKR. However, a full-clinical trial is needed to establish the effect on SED.

Keywords

physical activity; sedentary behavior; intervention; outcomes; pilot study

Introduction:

Worldwide, over 250 million adults have knee osteoarthritis (OA), which is a serious disease given it is painful, causes functional limitation, and has no cure (Lee et al., 2012). All current treatments focus on reducing pain and functional limitation, with the definitive treatment for end-stage knee OA being total knee replacement (TKR). Despite improvements in pain and physical function after TKR, many adults continue to be highly sedentary, i.e., spending the majority of waking time sitting or lying on a couch, and physically inactive, i.e., engaging in little moderate-to-vigorous intensity physical activity (MVPA) (George, Ruiz, & Sloan, 2008; Hammett et al., 2018). High levels of sedentary time (SED) and little to no time in MVPA are independently associated with increased risk of chronic diseases, all-cause mortality, and disability (Biswas et al., 2015; Dunlop et al., 2015; Semanik et al., 2015).

To promote engagement in physical activity (PA) after TKR, a physical therapist-administered PA intervention was developed (Christiansen et al., 2019). The findings of this pilot trial indicated that adults who received the PA intervention during physical therapy (PT) after TKR increased their time in MVPA more than the control group, from initial evaluation (IE) to discharge (DC) from PT, and 12 months (12M) after DC from PT (Christiansen et al., 2019). However, change in SED (ΔSED) following the intervention is not known. This investigation is important because people can have improvements in MVPA but continue to be sedentary. Therefore, the purpose of this study is to investigate the short- and long-term ΔSED following a physical therapist-administered PA intervention in people after TKR. We define short-term as IE to DC from PT, and long-term as IE to 12M after DC from PT. We hypothesized that the intervention group will have a greater reduction in SED compared to the control group in the short- and long-term.

Methods:

This study was an exploratory secondary data analysis of a pilot randomized controlled trial conducted between 2015 and 2017. The detailed description and findings of this trial have been previously published (Christiansen et al., 2019). We intended to recruit 72 participants (36 participants in each group), however, we had to stop the enrollment at 43 participants since we received funding for a larger trial to investigate the effectiveness of a physical therapist-administered PA intervention. Briefly, we included adults undergoing outpatient PT in an academic setting in the United States after a unilateral TKR who were ≥ 45 years of age, were not planning or did not have another lower extremity surgery for six months after TKR, and were interested in increasing their PA. After providing informed consent, participants were randomized to the intervention or control group. Participants were excluded if they had a comorbidity that would prevent them from participating in a PA intervention such as unstable angina. Both groups received standard PT after TKR and up to 6 monthly follow-up phone calls after DC from PT. The intervention group also received a Fitbit Zip, weekly step goals during PT, and a discussion within each follow-up phone call to set step goals after DC from PT.

We measured SED using a triaxial accelerometer, i.e., Actigraph GT3X (Pensacola, FL, USA), worn for 7 days at 3 timepoints: IE, DC from PT, and 12M from DC. Valid accelerometry data requires ≥10 hours/day of wear for ≥ 4 days (Troiano et al., 2008). SED was defined as time spent in <100 activity counts/minute. We standardized SED to 16 waking hours/day [(time spent in <100 activity counts/minute ÷ wear time/day) * 16 hours] to minimize variability in wear times between participants. Our primary outcome, ΔSED, was calculated as the difference in SED from IE to DC (short-term ΔSED) and IE to 12M (long-term ΔSED; positive values indicated a reduction in SED.

In this analysis, we included participants with valid accelerometry data at IE and DC for short-term ΔSED, and at IE and 12M for long-term ΔSED. To contextualize our findings, we also reported short- and long-term ΔMVPA for the participants included in our analysis. These data were previously reported in full as all data points were considered in the analysis (Christiansen et al., 2019). For ΔMVPA, positive values indicate an increase in time spent in MVPA.

Descriptive statistics were used to define the demographic characteristics of the sample. We computed means and 95% confidence intervals (95% CI) to quantify the short- and long-term ΔSED and ΔMVPA. We compared ΔSED and ΔMVPA between the intervention and control groups using independent t-tests. The analysis was conducted in SAS version 9.4 (SAS Institute Inc, Cary, NC, USA).

Results:

Of the 43 participants [mean(SD) age 67.0 (7.0) years, BMI 31.5 (5.9) kg/m^2, 53% female], 36 participants had valid accelerometry data at IE and DC (18 intervention, 18 control), and 27 had valid accelerometry data at IE and 12M (12 intervention, 15 control). At IE, participants in the intervention group has similar SED compared to those in the control group. About half of the total sample had one or more comorbidities including cardiovascular disease, COPD, stroke, cancer, history of falls, diabetes mellitus, or depression. The frequency of comorbidity was similarly distributed between the intervention and control groups.

In the short-term (IE to DC), SED decreased while time in MVPA increased for the intervention and control groups (Table 1). Further, participants in the intervention group demonstrated greater reductions in SED (mean difference 32.9 [−14.4, 80.1] minutes/day), and greater improvements in MVPA (mean difference 14.3 [2.2, 26.5] minutes/day) compared to the control group (Table 1).

In the long-term, (IE to 12M), SED decreased while time in MVPA increased for the intervention and control groups (Table 1). Participants in the intervention group demonstrated greater reductions in SED (mean difference 59.2 [8.6, 109.7] minutes/day), and greater improvements in MVPA (mean difference 8.6 [−0.1, 17.3] minutes/day) compared to the control group (Table 1).

Discussion:

These preliminary results indicate that participants who received the intervention reduced SED more than the control group in the short- and long-term. The difference in ΔSED between the two groups was above and beyond the difference in ΔMVPA in the short- and long-term.

The difference between the two groups was not significant in the short-term, which may be due to lack of power to observe difference in ΔSED. Yet, these results of the exploratory analysis suggest that a PT-led PA intervention during rehabilitation after TKR may also improve sedentary behavior, in addition to MVPA. These findings highlight the potential to further improve SED if strategies to specifically target a reduction in SED are included during PT.

The difference in ΔSED between the two groups was greater (i.e. 60 minutes/day) in the long-term, which can be partially attributed to participants in the control group spending more time in SED at the 12M timepoint. Additionally, we believe that greater reduction in SED in the intervention group is not fully reflected by an increase in MVPA, suggesting that instead there may have been an increase in light physical activity (LPA), (such as walking slowly or gardening,) which may have reduced SED. Future full-scale clinical trials are needed to fully explore the effects of the intervention on the interplay between different intensities of PA and sedentary behavior from a compositional perspective.

Study Limitations:

A strength of our analysis was that SED was measured objectively using a research-grade wearable accelerometer that did not provide biofeedback regarding SED to participants. Our study had several limitations. We had a small sample size with 25% loss to follow-up, or drop out, between DC and 12M. Further, missing data was not accounted for by multiple imputation methodology given the intent of this study was to observe the SED changes in short- and long-term descriptively among the participants who completed the study. Therefore, our study findings should be viewed conservatively. Lastly, this was a pilot study; these findings should not be considered conclusive, but instead, viewed as a first step for developing a full-scale randomized control trial to determine the effects of an intervention that combines increasing MVPA and decreasing SED to improve health outcomes following TKR.

Conclusion:

Based on this pilot study, participants who receive a PA intervention may also reduce SED compared to those in control group. However, future trials are needed to examine the shortand long-term effectiveness of a PA intervention that not only increases MVPA, but also reduces SED following TKR.

Acknowledgments:

Some parts of this manuscript were presented at the American Physical Therapy Association Combined Sections Meeting in Denver, February 2020.

Funding:

This work was supported by National Institute of Health. [Grant numbers R21-AR-071079-01A1, U54-GM-104941, and K12-HD-055931-01]

References:

Biswas A, Oh PI, Faulkner GE, Bajaj RR, Silver MA, Mitchell MS, & Alter DA (2015). Sedentary time and its association with risk for disease incidence, mortality, and hospitalization in adults: a systematic review and meta-analysis. Ann Intern Med, 162(2), 123–132. doi:10.7326/M14-1651 [PubMed: 25599350]

Christiansen MB, Thoma LM, Master H, Voinier D, Schmitt LA, Ziegler ML, … White DK (2019). The feasibility and preliminary outcomes of a physical therapist-administered physical activity intervention after total knee replacement. Arthritis Care Res (Hoboken). doi:10.1002/acr.23882

Dunlop DD, Song J, Arnston EK, Semanik PA, Lee J, Chang RW, & Hootman JM (2015). Sedentary time in US older adults associated with disability in activities of daily living independent of physical activity. J Phys Act Health, 12(1), 93–101. doi:10.1123/jpah.2013-0311 [PubMed: 24510000]

George LK, Ruiz D, & Sloan FA (2008). The effects of total knee arthroplasty on physical functioning in the older population. Arthritis Rheum, 58(10), 3166–3171. doi:10.1002/art.23888 [PubMed: 18821689]

Hammett T, Simonian A, Austin M, Butler R, Allen KD, Ledbetter L, & Goode AP (2018). Changes in Physical Activity After Total Hip or Knee Arthroplasty: A Systematic Review and Meta-Analysis of Six- and Twelve-Month Outcomes. Arthritis Care Res (Hoboken), 70(6), 892–901. doi:10.1002/acr.23415 [PubMed: 28898559]

Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT, & Group LPASW (2012). Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. Lancet, 380(9838), 219–229. doi:10.1016/S0140-6736(12)61031-9 [PubMed: 22818936]

Semanik PA, Lee J, Song J, Chang RW, Sohn MW, Ehrlich-Jones LS, … Dunlop DD (2015). Accelerometer-monitored sedentary behavior and observed physical function loss. Am J Public Health, 105(3), 560–566. doi:10.2105/AJPH.2014.302270 [PubMed: 25602883]

Troiano RP, Berrigan D, Dodd KW, Mâsse LC, Tilert T, & McDowell M (2008). Physical activity in the United States measured by accelerometer. Med Sci Sports Exerc, 40(1), 181–188. doi:10.1249/mss.0b013e31815a51b3 [PubMed: 18091006]

Table 1:

Short- and long-term changes in standardized sedentary time (SED) and time in moderate-to-vigorous intensity activity (MVPA). Positive number indicates reduction in SED and increase in MVPA.

	Short-term				Long-term			
	IE	DC	[1]Change	[2]Difference	IE	12M	[1]Change	[2]Difference
Number	18	18			12, 15**	12, 15**		
	Mean (SD)	Mean (SD)	Mean (95%CI)	Mean (95%CI)	Mean (SD)	Mean (SD)	Mean (95%CI)	Mean (95%CI)
SED (minutes/day)								
Intervention	742.6 (64.8)	651.6 (70.7)	91.1 (54.3, 127.8)		733.2 (69.7)	637.6 (67.6)	95.6 (58.8, 132.4)	
Control	741.6 (93.6)	683.4 (72.9)	58.2 (25.7, 90.7)	32.9 (−14.4, 80.1)	731.7 (96.4)	695.3 (73.6)	36.4 (−0.8, 73.7)	59.2 (8.6, 109.7)*
MVPA (minutes/day)								
Intervention	5.1 (5.4)	23.7 (24.9)	18.6 (6.9, 30.3)		4.6 (5.5)	19.4 (14.4)	14.7 (6.7, 22.8)	
Control	2.1 (2.2)	6.4 (9.4)	4.3 (−0.4, 8.9)	14.3 (2.2, 26.5)*	2.1 (2.2)	8.2 (10.4)	6.1 (1.0, 11.3)	8.6 (−0.1, 17.3)

[1]Change was calculated by subtracting values at DC and 12M time-points from IE

[2]Between group changes were tested using independent t-tests, (mean (95% CI)).

*Denotes statistical significance ($p < 0.05$)

**Intervention n=12, Control n=15