HHS Public Access

Author manuscript

Arthritis Care Res (Hoboken). Author manuscript; available in PMC 2015 December 01.

Published in final edited form as:

Arthritis Care Res (Hoboken). 2014 December ; 66(12): 1887–1894. doi:10.1002/acr.22398.

Increasing Steps/Day Predicts Improvement in Physical Function and Pain Interference in Adults with Fibromyalgia

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Abstract

Objective—To examine the concurrent and predictive associations between the number of steps taken per day (steps/day) and clinical outcomes in patients with fibromyalgia (FM).

Methods—199 adults with FM [mean age = 46.1 yr; 95% females] enrolled in a randomized clinical trial wore a hip-mounted accelerometer for 1 week and completed self-report measures of physical function [Fibromyalgia Impact Questionnaire-Physical Impairment (FIQ-PI), SF-36 physical component score (SF-36 PCS)], pain intensity and interference (Brief Pain Inventory; BPI), and depressive symptoms (Patient Health Questionnaire-8; PHQ-8) as part of their baseline and follow-up assessments. Associations of steps/day with self-report clinical measures were evaluated from baseline to week 12 using multivariate regression models adjusted for demographic and baseline covariates.

Results—Study participants were primarily sedentary, averaging 4,019 ± 1,530 steps/day. Our findings demonstrate a linear relationship between the change in steps/day and improvement in health outcomes for FM. Incremental increases on the order of 1,000 steps/day were significantly associated with (and predictive of) improvements in FIQ-PI, SF-36 PCS, BPI pain interference, and PHQ-8 (all $p<0.05$). Although higher step counts were associated with lower FIQ and BPI pain intensity scores, these were not statistically significant.

Conclusion—Step counts is an easily obtained and understood objective measure of daily physical activity. An exercise prescription that includes recommendations to gradually accumulate at least 5,000 additional steps/day may result in clinically significant improvements in outcomes relevant to patients with FM. Future studies are needed to elucidate the dose-response relationship between steps/day and patient outcomes in FM.

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Conflict of Interest

No professional relationships or conflicts of interest exist with any companies or manufacturers who will benefit from the results of the present study.

Keywords

Fibromyalgia; Physical activity; Steps/day; Physical function; Pain

Fibromyalgia (FM) is a complex multidimensional disorder characterized by chronic diffuse musculoskeletal pain, fatigue, disturbed sleep, and a reduced quality of life (1). The primary symptoms of FM are likely responsible for precipitating secondary indicators of the disease, including impaired functional ability (2), reduced physical activity participation (3), and below average exercise capacities (4). Medications are only beneficial in a minority of patients, often expensive, not available to everyone, and are sometimes not well tolerated (5). Consequently, an increasing amount of attention has been placed on self-management, non-pharmacological treatment strategies designed to help patients with FM achieve and maintain long-term symptom relief (6, 7).

Physical activity and exercise are strongly recommended adjunct components in the overall medical management of FM (8–10). However, in order to sufficiently elucidate the relationship between increased physical activity and the subsequent improvement in clinical outcomes, a valid and reliable measure of physical activity is necessary. Objective monitoring of physical activity using accelerometry technology overcomes some of the limitations associated with subjective measures (e.g. recall error) and currently provides the most accurate and efficient means of documenting both the quantity and quality of physical activity within a given population. However, despite the enormity of data that actigraphy can provide, accelerometry use for clinical applications may not be highly valued by physicians (or patients) since they are relatively expensive, require additional time and expertise to manipulate the data, and the interpretation of the data is not necessarily straightforward or clinically intuitive.

In recent years, the assessment and interpretation of the number of steps taken per day (steps/day) has gained increased acceptance by both researchers and healthcare professionals as a clinically relevant metric to use for the classification of a “sedentary lifestyle” and for prescribing step-based physical activity recommendations (11, 12). Categories of step-defined sedentary behavior (<5,000 steps/day) and different levels of physical activity (low active: 5,000–7,499; somewhat active: 7,500–9,999; active: 10,000–12,499; and highly active ≥12,500) have been developed and validated (11). Walking is the most frequently reported leisure-time activity among the general population (13) and is regarded as having the greatest likelihood of becoming a sustained exercise program in FM (14). In this regard, measurement of steps/day offers an easily understood, objective metric of daily physical activity that may provide clinically important information regarding the relationship between walking behavior and improvement in key health outcomes in FM. Therefore, the main purpose of this paper was to examine the relationship between steps/day and self-report measures of physical function and pain symptoms in adult patients with FM.

In our recently completed randomized clinical trial that evaluated the efficacy of motivational interviewing (MI) to increase physical activity participation in adults with FM, an objective measure of physical activity (actigraphy) was included as part of the overall assessment (15). In this trial, both intervention groups received a structured exercise

prescription at the onset of the study, but only one group was given MI, which we hypothesized would increase adherence to the prescribed exercise program and increase overall levels of voluntary physical activity. Actigraphy was used as a secondary outcome measure to objectively measure the quantity and quality of physical activity performed.

The specific aims of this paper were to: 1) examine the concurrent relationship between the change in the number of steps/day and improvement in physical function and pain symptoms; and 2) examine the predictive association between the change in the number of steps/day and subsequent changes in physical function and pain symptoms. Our primary hypothesis was that patients with FM who increased the number of steps/day would report greater improvement in physical function and pain symptoms. Our secondary hypothesis was that the change in the number of steps/day would predict better outcomes in terms of physical function and pain symptoms.

MATERIALS AND METHODS

Experimental Design

This was a secondary data analysis from our recently completed randomized, attention-controlled clinical trial of the efficacy of MI to increase voluntary physical activity participation in adults with FM (15). In the primary study, participants were randomized to either an MI intervention or education attention control (AC) group. Participants in both groups received two supervised exercise sessions and an individualized exercise prescription that included the initial exercise intensity, duration, and frequency, as well as the progression of the exercise program over the ensuing 36 weeks. Complete details of the exercise program can be found elsewhere (16). Following completion of the supervised exercise sessions, participants received six exercise-based (MI group) or six FM-related health education (AC group) telephone calls over the ensuing 12 weeks. Outcome assessments were conducted at week 12 (immediate post-intervention), week 24 (3-month follow-up) and week 36 (6-month follow-up). Although MI caused short-term improvements in pain intensity and self-reported physical activity, it was not efficacious in increasing voluntary physical activity and reducing physical impairment beyond week 12. After week 12, none of the physical activity measures and FM-related symptoms changed for either the MI or the AC group (15). As such, for this paper, we restricted our analyses to the baseline to week 12 time frame where changes in the study variables were observed. The study protocol was approved by the Indiana University Institutional Review Board and carried out in accordance with *The Code of Ethics of the World Medical Association (Declaration of Helsinki)*.

Study Participants

All study participants were referred from specialty or primary care clinics with an initial diagnosis of FM, which was confirmed by the study physician (a rheumatologist). Complete details of participant recruitment, including inclusion/exclusion criteria have been described elsewhere (16). Briefly, all participants had to meet the following entry criteria: (a) male or female between 18–65 years old; (b) 1990 American College of Rheumatology classification criteria for FM (17); and (c) Brief Pain Inventory (BPI) pain intensity score ≥ 4. The primary

exclusion criteria were known cardiovascular or pulmonary disease, any musculoskeletal or neurological disorders that would exclude moderate-intensity physical activity participation, other inflammatory rheumatic conditions (e.g. rheumatoid arthritis, systemic lupus, or other connective tissue disease), treatment with drugs affecting the chronotropic response to exercise (e.g. beta-blockers), and participation in moderate-vigorous physical activity on three or more days a week during the previous six months. A total of 216 individuals (22% of the total sample screened) met the inclusion criteria and were enrolled in the original study. Of these, 199 participants (92%) had complete data for all clinical and physical activity outcome measures at baseline and immediate post-intervention (12-wk follow-up) and were included in the final analyses. There were no significant differences in any baseline variable for those subjects not included in the final analyses.

Outcome Measures

Physical Activity Assessment—Steps/day served as the primary measure of physical activity for this study. Data were collected with the ActiGraph Model GT1M accelerometer (ActiGraph®, Pensacola, FL), which has been shown to be a valid and reliable instrument of the volume of physical activity performed (18), including the detection of step counts (19). Prior to distribution, the activity monitors were initialized as described by the manufacturer. Written and verbal instructions were provided to each participant on how to wear the device. The activity monitor was worn on the waist with a belt clip and was programmed to record information each minute throughout the day for 7 days. Participants were instructed to remove the device prior to participating in any water activities (e.g. swimming, bathing, and showering) and prior to going to bed. Upon completion of the 7-day monitoring period, accelerometers were returned to the research staff by prepaid mail. The data were subsequently processed and edited to exclude any outliers or physiologically unreasonable values. Examples of values flagged as spurious and excluded from the analyses include: 1) non-wear time, defined as intervals of 60 consecutive minutes of zero activity counts (with allowance for up to 2 minutes of counts between 0 and 100) (20); 2) steps taken at <100 counts per minute, which was considered consistent with time spent in sedentary activities (e.g. sitting quietly, working at a desk) (21); and 3) activity counts greater than 20,000 per minute, which was considered a malfunction of the accelerometer (22). Data collected from activity monitors that were out of calibration upon return also were flagged as unreliable. To be included in the analyses, a valid day was defined as having a minimum of 10 hours of wear time, and participants were required to have at least 4 valid days (20). Participants not adhering to the required number of days and hours were asked to re-wear the monitor. Step count data were summed over the waking hours of the day and then divided by the number of days the accelerometer was worn to determine the average number of steps taken per day.

Physical Function, Quality of Life, and Disease Impact—The *Fibromyalgia Impact Questionnaire (FIQ)* is a self-assessment instrument frequently used in clinical trials to assess the impact of FM across several dimensions (23). The first section consists of 10 items that inquire about the patient's ability to perform different physical activities, with each item rated on a four-point Likert-type scale. The total physical impairment score (FIQ-PI) represents the sum of these 10 items divided by the number of valid scores. Higher

scores on the FIQ indicate a greater impact of FM on the individual. The reliability and validity of the FIQ-physical impairment scale are well established (24, 25).

The *Brief Pain Inventory (BPI)* is a self-administered assessment tool designed to assess pain on two domains – BPI pain intensity and BPI pain interference (26). BPI pain intensity is the mean score of four items asking about the worst, least, and average pain in the last week, and the current level of pain. BPI pain interference measures the impact of pain on 7 life domains, including general activity, mood, walking ability, normal work, relations with others, sleep and life enjoyment. Higher scores are associated with greater interference. A ≥ 30% reduction in the BPI pain score is considered clinically meaningful improvement of pain intensity (27). Among patients with chronic non-malignant pain, the BPI has been proven reliable, valid, and responsive to change (28).

The *Medical Outcomes Study Short Form-36 (SF-36)* questionnaire is a frequently used self-administered instrument for the assessment of heath-related quality of life. The SF-36 comprises eight categories of health, including physical function, body pain, role physical, role emotional, general health, vitality, social functioning, and mental heath. These domains are separated into either composite physical health or mental health, and combined to provide a total SF-36 score, where a higher score indicates a better health outcome. For the current study, we calculated the Physical Component Summary (PCS) score, which includes the following subscales: physical functioning, bodily pain, role-physical and general health. A 7-point change in the SF-36 PCS has been shown to be clinically relevant in patients with chronic illnesses (29). The SF-36 has well-documented validity and reliability in healthy and chronic disease populations (30, 31).

The *Patient Health Questionnaire 8-item Depression Scale (PHQ-8)* is a brief, self-administered questionnaire designed to evaluate major depressive disorder core symptoms. The PHQ-8 allows a score (range: 0 to 24) based on the frequency and severity of depressive symptoms over the previous two weeks. The validity of the PHQ-8 to detect changes in depressive symptoms over time is well established (32, 33).

Statistical analyses

Descriptive statistics are given for demographic, clinical, and physical activity (steps/day). Student's t-tests were performed to determine if there had been a significant change over time, from baseline to week 12, for each variable on a univariate level. Multivariate regression models were used to determine if the independent variable, change in steps/day, had any associations with our set of clinical outcomes. To identify potential confounders, we assessed the relationships between participant demographic and clinical characteristics with the primary outcomes of interest. Only education and use of narcotics were associated with our set of clinical outcomes; therefore, we adjusted the analyses for education, narcotic use, treatment group, and the outcome measure at baseline. The outcome measures were analyzed both by the change from baseline to week 12 and by their measures at the end of week 12. All analytic assumptions were verified and met, and collinearity was tested for each model. Outcomes were considered significant at an alpha level of 0.05, indicating that the change in steps per day had a significant association with the outcome measures. Analyses were performed using SAS v9.3 (SAS Institute, Cary, NC).

RESULTS

Descriptive data for all participants are presented in Table 1. Of the 216 participants enrolled in the original study, 17 had missing or incomplete data and were not included in the final analyses (n=199). The majority of participants were female (95.5%), Caucasian (87.9%), with a mean (SD) age of 46 (11.3) years. Approximately 50% of the participants were employed with the majority (79.4%) having some education beyond high school. Overall, the participants in this study represented a primarily sedentary FM population [steps/day=4,019 (1,530)] that was moderately depressed [PHQ-8=12.4 (4.9)] and with self-reported moderate-to-severe physical impairment [FIQ-PI=5.4 (1.6)] and pain intensity [BPI pain intensity=6.0 (1.3)].

In general, all clinical values significantly improved over time (Table 2). BPI and FIQ scores decreased, showing improvement, as well as depressive symptoms decreasing from baseline to week 12. SF-36 PCS scores increased from baseline to week 12, indicating improvement.

Table 3 shows the multivariate concurrent associations of the change in steps/day from baseline and the change in clinical outcomes measured from baseline to week 12; and the association of the change in steps/day and the clinical outcome measurement at week 12. These results demonstrate that for every 1,000 incremental steps/day, scores for FIQ-PI, BPI pain interference, and PHQ-8 were significantly lower and SF-36 PCS scores were significantly higher (all $p<0.05$). In general, the other clinical outcomes (FIQ and BPI pain intensity) showed lower scores (indicating improvement) with higher step counts, but these relationships were not statistically significant.

Table 4 presents examples of the estimated improvement in our clinical outcomes associated with an increase of “X” number of steps/day. Although the values shown are based on regression analyses from our data, we estimate that a sedentary patient who takes additional steps/day would have a 30% improvement in self-report physical function and pain symptoms by increasing daily step counts to meet current public health recommendations (i.e. 7,000–8,000 steps/day) (11, 12, 34). Further, while the clinical significance of these associations will vary by the baseline score of the outcome measure, our findings indicate that increases of 4,900 steps/day and 8,200 steps/day, respectively, are associated with clinically meaningful improvements in physical function (SF-36 PCS) and pain interference (BPI pain interference).

DISCUSSION

Our study is the first to demonstrate both a concurrent and predictive association between steps/day and self-report measures of physical function and pain interference in patients with FM. Specifically, a higher step count measured at the 12-wk follow-up period than at baseline was associated with (and predictive of) significant improvements in self-reported physical function (FIQ-PI, SF-36 PCS), physical impairment (BPI pain interference), and depressive symptoms (PHQ-8). Although walking more was not significantly associated

with an improvement in pain intensity (BPI pain intensity), it is encouraging that increased ambulatory activity was not associated with worsening pain symptoms.

Several recent reviews and meta-analyses have documented the benefits of regular aerobic exercise for individuals with FM (9, 10, 35, 36). While the majority of these studies have focused on pool or land-based exercise that include walking as an optional mode of exercise, several complementary and alternative exercise therapies also have been shown to improve outcomes important to patients with FM (7). In recent years, step counting has gained widespread acceptance by researchers and practitioners as a means to assess, track, and communicate physical activity patterns. However, the use of wearable monitors (i.e. accelerometers and pedometers) in FM research is relatively new. In the current study, we focused on steps/day because walking is integral to daily life and is a well supported form of exercise that is associated with multiple benefits important to patients with FM, including weight management (37), reduced blood pressure (37), improved glucose sensitivity (38), and reduced risk of falling (39). Given that step counts is an objective measure of total daily physical activity that can be easily communicated to the public and directly translated to the clinical setting, quantifying and examining steps/day may be an important behavioral measure to monitor in patients with FM.

Several studies have reported that accumulating <5,000 steps/day is associated with several adverse cardiometabolic health indicators, including increased adiposity (40), hypertension (41), and metabolic syndrome (42). Of particular relevance to patients with FM, McKercher et al. (43) reported that the prevalence of depression was 50% higher in women walking <5,000 steps/day compared to those taking ≥7,500 steps/day. Unfortunately, the clinical utility of steps/day is limited without normative data of the population being studied, as well as the ability to translate measures of steps/day to current physical activity guidelines. Although normative step count data have been documented for apparently healthy and older adults (44–46) the pain community knows very little about the expected values of steps/day for patients with FM. Using the graduated step index of Tudor-Locke and Bassett (11), patients in the current study were categorized as “sedentary” at study entry, walking on average 4,019 steps/day. These step counts are slightly higher than those published by Fontaine et al. (47), who reported baseline counts of 3,788 steps/day and 3,071 steps/day, respectively for FM patients receiving either a lifestyle physical activity or FM-related education intervention. Thus, compared to the available research to date, it appears that patients in the current study are participating in insufficient levels of physical activity necessary to achieve important health and fitness benefits.

Despite the abundance of aerobic-based intervention studies in FM, research examining the relationship between the number of steps taken per day and clinical outcomes in FM are noticeably absent. From the published literature, we identified only one other study that examined the longitudinal relationship between steps/day and health outcomes in FM. In the study by Fontaine et al. (47), patients with FM were randomly assigned to a lifestyle physical activity group or a FM education control group. After 12 weeks, patients assigned to the lifestyle physical activity group had increased their average daily step count by 54% and reported significant reductions in physical function and pain after 12 weeks (47). These benefits were not sustained at 6- and 12-month follow-up; however, patients in the lifestyle

physical activity group had a 12-month daily step count that was 44% higher compared to baseline. A reduced sample size (only 73% of original cohort completed all follow-up assessments) was cited as a possible reason for the lack of statistically significant findings at follow-up (48). While average steps/day did not significantly increase in our study cohort after 12 weeks, we found that a higher daily step count was a significant predictor of lower scores on self-report measures of physical function, pain-related interference with daily activities, and depressive symptoms.

The present study does have several limitations that should be taken into consideration. First, given that accelerometry is known to miss certain activities (e.g. upper-body movements, cycling, load carrying, water activities) and underestimate others (e.g. weight training, yoga, etc.), it is possible that participation in other forms of non-stepping activities biased our study results. However, considering that the prevalence of these types of activities is generally low (13), we feel that most of the activity undertaken by the participants was captured. Second, we acknowledge that the measurement of steps/day is not a direct indicator of exercise intensity, an important component of current public health recommendations. Nevertheless, the measurement of steps/day is an indicator of total daily ambulatory activity, regardless of the speed at which it was accumulated. Third, we admit that the linear aspect of the improvement in our clinical outcome measures may not hold as shown in Table 4, but felt it was important to provide clinicians with a broad picture of the improvements that may be observed. Lastly, although the clinical characteristics of our study participants are comparable to other psychoeducational-based clinical trials in FM (49), given that the majority of participants in the current study were females reporting higher levels of pain severity, our findings may not be generalizable to male patients with FM, or to those with less severe pain symptoms. Despite these limitations, the strengths of our study include its longitudinal design, large sample size, low dropout rate (8%), and use of an objective measure of physical activity. Although pedometers are more likely to be used for clinical applications and by the general public, accelerometers are known to be more sensitive than pedometers to ambulatory activities such as walking (50). Finally, the associations between steps/day and our clinical outcome measures were observed both concurrently and prospectively, which strengthens our findings.

To our knowledge, this is the first study to report on the concurrent and predictive association between steps/day and physical function and pain symptoms in patients with FM. Our findings indicate a linear relationship between the change in steps/day and improvement in key health outcomes. Given the numerous health concerns associated with low levels of physical activity, measurement of steps/day may aid clinicians in the identification of patients at increased risk for the detrimental effects of a sedentary lifestyle; and thus, would most likely derive the greatest health benefit (including FM-relevant clinical outcomes) through increased physical activity. Furthermore, the measurement of steps/day may, if investigated in future clinical trials, improve upon current screening practices by providing an objective surrogate marker of FM disease severity. Although prospective data are still needed in order to better understand the dose-response relationship between steps/day and clinical outcomes, as well as to determine the attainability of higher step count recommendations in patients with FM, this study provides preliminary evidence to support

the recommendation for low active patients with FM to gradually accumulate at least 5,000 additional steps/day to achieve clinically significant improvement in health outcomes.

Acknowledgments

Funding Support: This study was supported by a grant from the National Institute of Arthritis and Musculoskeletal and Skin Diseases (Grant number: 1RO1AR054324-01A1)

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SIGNIFICANCE AND INNOVATION

- To our knowledge, this is the first study to examine the concurrent and predictive association between steps/day and fibromyalgia-related clinical outcomes.
- Walking an additional 1,000 steps/day was associated with (and predictive of) improvement in self-reported physical function, physical impairment, and depressive symptoms, with no detrimental effect on pain intensity.
- Measurement of steps/day offers an easily understood, objective measure of daily physical activity that may provide clinically important information regarding the relationship between walking behavior and improvement in key health outcomes in fibromyalgia.

Table 1

Baseline characteristics of 199 subjects with complete clinical and accelerometry data at baseline and week 12

Demographics	
Age in years	46.14 (11.19)
Gender, % female	190 (95.5%)
Ethnicity, % non-Hispanic	3 (1.5%)
Race, % white	175 (87.9%)
Education, % > high school	158 (79.4%)
Marital status, % married	121 (60.8%)
Employment, % employed	106 (53.3%)
Clinical Variables	
Body mass index (kg/m^2)	31.55 (7.21)
Duration of fibromyalgia diagnosis (years)	9.33 (6.97)
FIQ total (range 0–100)†	66.77 (12.65)
FIQ-physical impairment (range 0–10)†	5.39 (1.58)
BPI pain intensity (range 0–10)†	5.97 (1.27)
BPI pain interference (range 0–10)†	6.56 (1.78)
PHQ-8 depression (range 0–24)†	12.44 (4.94)
SF-36 PCS (range 0–100)$^{£}$	40.75 (19.05)
Medications, % prescribed	
Non-tricyclic antidepressants	106 (53.3%)
Anticonvulsants	59 (29.7%)
Opioid analgesics	66 (33.2%)
Physical Activity Measure	
Number of steps/day	4018.70 (1529.66)

*Values are the means (standard deviation) unless otherwise indicated.

†Higher score indicates a worse state of health.

$^{£}$Lower score indicates a worse state of health.

Abbreviations: FIQ = Fibromyalgia Impact Questionnaire; BPI = Brief Pain Inventory; PHQ-8 = Patient Health Questionnaire-8; SF-36 PCS = Short Form-36 (Physical Component Score).

Table 2

Changes in steps/day and self-report outcomes at week 12 compared to baseline (n=199)

	Baseline Mean (SD)	Wk 12 Mean (SD)	Mean change (SD)	P-values
FIQ total (range 0–100)†	66.77 (12.65)	54.40 (18.35)	−12.25 (16.21)	<0.0001
FIQ-PI (range 0–10)†	5.39 (1.58)	3.86 (2.04)	−1.53 (2.07)	<0.0001
BPI pain intensity (range 0–10)†	5.97 (1.27)	4.90 (1.75)	−1.07 (1.69)	<0.0001
BPI pain interference (range 0–10)†	6.56 (1.78)	5.07 (2.26)	−1.49 (2.04)	<0.0001
PHQ-8 depression (range 0–24)†	12.44 (4.94)	9.33 (5.36)	−3.11 (5.01)	<0.0001
SF-36 PCS (range 0–100)£	40.75 (19.05)	51.38 (21.55)	10.63 (16.70)	<0.0001
Steps/Day	4019 (1530)	3946 (1683)	−95 (1345)	0.0005

*Values are the means (standard deviation) unless otherwise indicated.

†Higher score indicates a worse state of health.

£Lower score indicates a worse state of health.

Abbreviations: FIQ = Fibromyalgia Impact Questionnaire-physical impairment; BPI = Brief Pain Inventory; PHQ-8 = Patient Health Questionnaire-8; SF-36 PCS = Short Form-36 (Physical Component Score).

Table 3

Multivariate regression models showing associations of change in steps/day (per 1,000 steps) and self-report clinical outcomes

	β for *change* in outcome at week 12	P-value	β for outcome measure *at* week 12	P-value
FIQ total	−1.48	0.1070	−1.50	0.0919
FIQ-PI	−0.33	0.0040	−0.23	0.0288
BPI pain intensity	−0.01	0.8902	−0.01	0.8736
BPI pain interference	−0.27	0.0179	−0.24	0.0270
PHQ-8	−0.60	0.0301	−0.66	0.0090
SF-36 PCS	2.21	0.0169	2.05	0.0187

Models are adjusted for education, narcotic use, and group assignment; also for the outcome at baseline when analyzing the outcome at week 12.

Abbreviations: FIQ = Fibromyalgia Impact Questionnaire-physical impairment; BPI = Brief Pain Inventory; PHQ-8 = Patient Health Questionnaire-8; SF-36 PCS = Short Form-36 (Physical Component Score).

Table 4

Estimated improvement in clinical outcomes associated with incremental increases in steps/day above baseline

Increment (steps/day)	FIQ-PI	BPI-PI	SF-36 PCS	PHQ-8
2,000	−0.66 (−1.84, −0.31)	−0.54 (−2.27, −0.09)	4.43 (0.80, 8.05)	−1.21 (−2.30, −0.11)
3,000	−0.99 (−1.66, −0.32)	−0.81 (−1.48, −0.14)	6.64 (1.21, 12.07)	−1.81 (−3.44, −0.18)
4,000	−1.32 (−2.21, −0.43)	−1.09 (−1.98, −0.19)	8.85 (1.61, 16.10)	−2.41 (−4.59, −0.23)
5,000	−1.65 (−2.76, −0.53)	−1.36 (−2.48, −0.24)	11.07 (2.01, 20.12)	−3.02 (−5.74, −0.29)
6,000	−1.98 (−3.32, −0.64)	−1.63 (−2.97, −0.28)	13.28 (2.41, 24.15)	−3.62 (−6.89, −0.35)
7,000	−2.31 (−3.87, −0.75)	−1.90 (−3.47, −0.33)	15.49 (2.82, 28.17)	−4.22 (−8.03, −0.41)
8,000	−2.64 (−4.42, −0.85)	−2.17 (−3.96, −0.38)	17.71 (3.22, 32.20)	−4.83 (−9.18, −0.47)
10,000	−3.30 (−5.53, −1.07)	−2.71 (−4.95, −0.47)	22.13 (4.02, 40.25)	−6.03 (−11.48, −0.59)

Values are means (95% confidence intervals) of regression slope parameters.

Abbreviations: FIQ-PI = Fibromyalgia Impact Questionnaire-Physical impairment; BPI = Brief Pain Inventory-pain interference; SF-36 PCS = Short Form-36 (Physical Component Score); PHQ-8 = Patient Health Questionnaire-8.