

Opioid use and walking among patients with chronic low back pain

Sarah L. Krein, PhD, RN;^{1–2*} Amy Bohnert, PhD;^{1,3} Hyungjin Myra Kim, ScD;^{1,4} Meredith E. Harris, BA;⁵ Caroline R. Richardson, MD^{1,6}

¹Center for Clinical Management Research, Department of Veterans Affairs Ann Arbor Healthcare System, Ann Arbor, MI; Departments of ²Internal Medicine and ³Psychiatry, University of Michigan Medical School, Ann Arbor, MI;

⁴Center for Statistical Consultation and Research, University of Michigan, Ann Arbor, MI; ⁵University of Cincinnati College of Medicine, Cincinnati, OH; ⁶Department of Family Medicine, University of Michigan Medical School, Ann Arbor, MI

Abstract—This study examined the effect of a walking intervention on step counts among patients with chronic back pain who report opioid use. Data were collected as part of a randomized trial to reduce back-pain-related disability. Participants ($n = 118$ usual care, 111 intervention) were Veterans receiving care within one healthcare system. Step counts were collected at baseline, 6 mo, and 12 mo via an uploading pedometer. Self-reported opioid use was collected by survey. More than 40% ($n = 99$) of participants reported opioid use at baseline. After adjustment, the predicted mean step count for baseline opioid users assigned to the intervention increased by more than 1,200 steps compared with a reduction of nearly 400 steps for those assigned to usual care (between-group difference = 1,625 steps, $p = 0.004$). Among nonopioid users, there was no change for those in the intervention (−16 steps) and an increase of about 660 steps for those assigned to usual care (between-group difference = 683 steps, $p = 0.17$). These data show that patients taking opioids may engage in walking to help manage their back pain. This finding emphasizes the importance of encouraging the use of alternative pain management strategies for these patients.

Clinical Trial Registration: ClinicalTrials.gov; “Veterans Walk to Beat Back Pain”: NCT00694018; <https://clinicaltrials.gov/ct2/show/NCT00694018>

Key words: chronic back pain, exercise therapy, objective measurement, opioids, pain management, pain-related disability, pedometer, step counts, Veterans, walking.

INTRODUCTION

Managing chronic low back pain is a major public health and clinical challenge [1–4]. This challenge may be even more prominent within the Department of Veterans Affairs (VA) healthcare system, given that back pain is highly prevalent among VA general medicine patients and a chief complaint for Veterans who have returned from the conflicts in Iraq and Afghanistan [5–7]. Low back pain clinical guidelines recommend use of various self-care options, medications, and nonpharmacologic strategies, such as cognitive behavioral therapy or exercise therapy, when self-care alone does not lead to improvement [8]. However, the delivery of optimal back pain care appears to be an elusive goal [9–10].

An analysis of spine care in the United States showed that between 1999 and 2010 the use of guideline-concordant treatments, such as physical therapy or nonopioid medications (e.g., nonsteroidal anti-inflammatory drugs

Abbreviations: CES-D 10 = Center for Epidemiologic Studies Depression Scale, NSAID = nonsteroidal anti-inflammatory drug, RDQ = Roland and Morris Back Pain Disability Questionnaire, VA = Department of Veterans Affairs.

*Address all correspondence to Sarah L. Krein, PhD, RN; VA HSR&D (152), PO Box 130170, Ann Arbor, MI 48113; 734-845-3621; fax: 734-222-7503. Email: skrein@umich.edu <http://dx.doi.org/10.1682/JRRD.2014.08.0190>

[NSAIDs]), has remained stable or decreased [9]. On the other hand, the use of non-guideline-concordant therapy, such as advanced imaging and opioids, appears to be increasing [9]. Likewise, studies have found generally low use of nonpharmacologic therapies in clinical practice [2], while medications, including opioids, are commonly used for treating chronic back pain [2,11–12]. The use of opioids for chronic back pain is especially concerning given well-documented problems with safety and effectiveness, particularly with longer term use [3,11–16].

A recent Cochrane review identified randomized controlled trial evidence of short-term benefits with opioids versus placebo in reducing pain and improving function for individuals with chronic low back pain [14,17]. There are few studies, however, and no evidence that opioids are better than NSAIDs or antidepressants for addressing either pain or function and no data on the use of opioids for managing chronic back pain beyond 4 mo [17–18]. Whether patients receiving longer term opioid therapy can or will engage in physical activity, a recommended approach for managing chronic back pain [8,19–20], is also unknown. The purpose of this study, therefore, was to assess whether Veterans with chronic back pain, and particularly those who report opioid use, are willing to engage in physical activity by examining the effect of a walking intervention on objectively measured step counts.

METHODS

Study Population and Data Collection

Data were collected as part of a randomized controlled trial of a pedometer-based, Internet-mediated intervention to promote walking as a form of exercise therapy and reduce back-pain-related disability. The design, rationale, and main results for the primary study are described in detail elsewhere [21–22]. Briefly, we recruited patients with back pain from one VA healthcare system. Specific eligibility criteria included: (1) persistent back pain >3 mo, (2) sedentary lifestyle (<150 min of physical activity per week), (3) weekly access to a computer with a USB port and Internet access, (4) ability to provide consent and communicate in English, (5) community residence, (6) ability to walk at least one block; and (7) self-report not currently pregnant. After attending a single-session back class led by a physical therapist, all potential participants received an enhanced pedometer, Omron HJ-720ITC (Omron Healthcare, Inc; Lake Forest,

Illinois), which contains a dual axial accelerometer, stores 42 d of step count data, and has an embedded USB port [23]. Participants were instructed to wear the pedometer for 7 d with the step count display covered, allowing us to obtain a baseline measurement. After we received 7 d of valid pedometer data and a completed baseline survey, we randomized 229 participants, with 118 allocated to receive enhanced usual care (control group) and 111 allocated to receive the full intervention. The study protocol was approved by the VA Ann Arbor Healthcare System Institutional Review Board, with written informed consent obtained for all participants.

Results from the primary study showed that compared with participants receiving usual care, intervention participants reported a greater decrease in back-pain-related disability in the 6 mo following study enrollment, but the difference between groups was no longer significant at 12 mo [22]. The primary components of the intervention included (1) individualized step count goals, which participants received weekly via email; (2) feedback on progress toward meeting step count goals provided through a study Web site; (3) targeted educational and motivational messages posted on the Web site (e.g., tools for positive thinking, walking for your mind and spirit); and (4) social support provided through an asynchronous electronic forum accessed through the study Web site (i.e., an area on the Web site where intervention participants and research staff could share success stories, make suggestions, or ask questions). The weekly step goal email messages also served as a reminder for those in the intervention to upload their pedometer data. Usual care participants received a monthly email-based upload reminder. Reminders were also sent to all participants at 6 and 12 mo asking them to upload their pedometer data and complete an online study survey. The uploaded pedometer data along with the survey data collected at baseline, 6 mo, and 12 mo are the primary data sources for this study, although some data on opioid use were also obtained from VA electronic medical records.

Study Measures

The primary outcome was change in daily step counts. Step counts were measured as the average number of steps per day over the previous 7 d using step count data collected through pedometer uploads at baseline, 6 mo, and 12 mo. The change in daily steps was calculated by subtracting baseline step counts from step counts at 6 and 12 mo.

The principal independent variables were binary indicators of self-reported opioid use at baseline and assigned study group (intervention or usual care). Specifically, study participants who responded “yes” to the following question on the baseline survey: “Do you take a narcotic medication for pain relief?” (examples of narcotics include codeine, Tylenol[®] No. 3 with codeine, hydrocodone, Vicodin[®], hydromorphone, methadone, morphine, oxycodone, and Percocet[®]) were classified as using opioids. We used patient self-report as our primary measure of opioid use, given that some patients may obtain their medication outside of the VA system. However, prescription data from VA electronic pharmacy records were used to confirm our self-report classification as well as determine the receipt of opioid medications at 6 and 12 mo.

Other baseline variables included age, sex, race, body mass index, and the Center for Epidemiologic Studies Depression Scale (CES-D 10) [24]. Pain severity was evaluated using a numeric rating scale (0 = “no pain” and 10 = “worst pain imaginable”) [25], while back-pain-related disability, the primary outcome for the trial, was measured using the Roland and Morris Back Pain Disability Questionnaire (RDQ) [26], a 24-item scale with higher scores indicating greater disability. Both pain severity and back-pain-related disability were assessed at all three time points along with a self-efficacy for exercise measure, based on the Exercise Regularly Scale [27]. Study participants were also asked about the use of healthcare services during the past 6 mo, including the number of visits to a doctor’s office or clinic and the receipt of physical therapy and injections to help manage pain.

Statistical Analysis

We used *t*-tests and chi-square tests to compare the characteristics of participants who reported taking opioid medications at baseline versus those who did not. Differences in step counts, pain-related outcomes, and opioid use between intervention and control participants within opioid use subgroups were also assessed using *t*-tests and chi-square tests. The data were then analyzed using a linear mixed-effects model with the difference in daily steps from baseline at both 6 and 12 mo as the dependent variables. The independent variables consisted of the baseline daily step count, an indicator variable for opioid use at baseline, an indicator for intervention group, and an interaction term of opioid use at baseline by intervention group. The model also included baseline values for age, sex, body mass index, level of pain severity, RDQ score, exercise self-efficacy score, CES-D 10 Score, received

injections, received physical therapy, and number of outpatient visits in the prior 6 mo. An indicator for assessment time (e.g., 12 mo) was also included, and each participant’s data was modeled using random intercepts to account for within-patient correlation of the repeated measures. Step count changes were reported based on the predicted or marginal means generated by the model for the intervention and control participants within opioid use subgroups. All analyses were conducted using Stata/MP 13.1 (Stata Corp; College Station, Texas). Statistical tests were two-tailed, with $p < 0.05$ considered statistically significant.

Because of missing pedometer data at both 6 and 12 mo, as some participants were unable to or did not upload the information, we also conducted our analysis using multiple imputation. Specifically, at 6 mo, 38 participants (38%) in the baseline opioid use group and 34 (28%) in the no opioid use group were missing pedometer data; at 12 mo, 41 participants (41%) in the opioid use group and 40 (33%) in the no opioid use group were missing data. To account for missing covariates as well as missing outcomes, we created five imputed data sets by an iterative multivariable regression technique using all available baseline covariates we suspected to be relevant to the missing data mechanism, including baseline demographic variables, intervention group status, opioid use status, and follow-up outcomes. Across the imputed data sets, the estimates were combined using Rubin’s combining rules [28]. Since the directionality, magnitude, and statistical significance of our primary findings persisted, we present only the results from the nonimputed analysis.

RESULTS

At baseline, more than 40 percent (99/229) of participants reported using opioid medications for pain management. Only 8 participants did not self-report their opioid use status at baseline. Participant opioid use was confirmed through VA prescription data, with 83 percent of those who reported opioid use filling a prescription for an opioid medication in the prior 100 d compared with 7 percent of those who reported no opioid use (**Table 1**). Moreover, among self-reported opioid users, a majority (68%) had evidence of longer term use, defined as ≥ 16 wk [29]. The most frequently filled medications were hydrocodone-acetaminophen products followed by oxycodone or oxycodone-acetaminophen medications. There were no baseline differences between those using and not using opioids with

Table 1.Baseline characteristics for those reporting opioid use versus no opioid use. Data presented as *n* (%) or mean \pm standard deviation.

Variable	Opioid Use Reported at Baseline (<i>n</i> = 99)*	No Opioid Use Reported at Baseline (<i>n</i> = 122)*	<i>p</i> -Value
Age, yr	52.7 \pm 10.1	50.3 \pm 14.4	0.15
Male	88 (89)	105 (86)	0.53
White	80 (81)	98 (80)	0.93
Body Mass Index	31.3 \pm 5.5	30.8 \pm 5.6	0.53
Level of Pain Severity (0–10)	6.3 \pm 1.7	5.8 \pm 1.8	0.02
RDQ Score (0–24)	10.5 \pm 5.9	8.6 \pm 5.5	0.02
Exercise Self-Efficacy Score	6.1 \pm 2.2	7.1 \pm 2.2	0.001
Depression Score	14.8 \pm 6.1	11.6 \pm 6.6	<0.001
No. Outpatient Visits in Past 6 mo	10.3 (12.1)	9.1 (11.3)	0.45
Received Injections in Past 6 mo	21 (21)	10 (8)	0.006
Received Physical Therapy in Past 6 mo	39 (39)	44 (36)	0.61
In Intervention Group	44 (44)	64 (52)	0.24
VA Fill for Opioid Medication in Prior 100 d	82 (83)	8 (7)	<0.001
Baseline Daily Step Counts	4,005.4 \pm 2,131.3	4,811.3 \pm 2,770.8	0.02

**n* = 8 missing/did not respond to opioid use question.

RDQ = Roland and Morris Back Pain Disability Questionnaire, VA = Department of Veterans Affairs.

respect to age, sex, race, body mass index, or number of outpatient visits in the prior 6 mo (**Table 1**). There was also no significant difference in the proportion of participants randomized to the study intervention group between those with and without reported opioid use. However, participants who reported using opioids at baseline had higher reported pain levels (6.3 vs 5.8, $p = 0.02$), higher back-pain-related disability scores (10.5 vs 8.6, $p = 0.02$), a higher reported level of depressive symptoms (14.8 vs 11.6, $p < 0.001$), and lower exercise self-efficacy scores (6.1 vs 7.1, $p = 0.001$) than those with no reported opioid use. A higher percentage of opioid users also reported that they were receiving injections to help manage their back pain (21% vs 8%, $p = 0.006$).

Average daily step counts were significantly lower for opioid users compared with nonusers at baseline (4,005.4 vs 4,811.3, $p = 0.02$). Likewise, average daily step counts remained lower at 6 mo (4,823.0 vs 5,242.2, $p = 0.42$) and 12 mo (4,599.3 vs 4,881.1, $p = 0.59$) for those participants who reported using opioid medications at baseline compared with those who did not. However, after taking into account assigned study group (intervention vs usual care), unadjusted changes in average daily steps were substantially greater at both 6 and 12 mo among those who reported opioid use at baseline who were assigned to the intervention (**Table 2**). At 6 mo, step counts for opioid users in the intervention group increased by more than 1,400 steps from baseline, compared with a decrease of

about 150 steps in those assigned to usual care (between-group difference = 1,632 steps, $p = 0.03$). In the nonopioid group, both intervention and usual care participants had relatively modest increases in their step counts, but the changes were not significantly different (between-group difference = 309 steps, $p = 0.68$). Similarly, at 12 mo, average step counts among baseline opioid users in the intervention were more than 1,000 steps higher than their baseline step counts, while those in the usual care group were more than 200 steps lower (between-group difference = 1,305 steps, $p = 0.05$); the changes for study participants with no reported opioid use were again not statistically different (between-group difference = 513 steps, $p = 0.31$).

Results from the linear mixed-effects model, as shown by the adjusted predicted mean difference in daily steps for each group averaged across the two follow-up times at 6 and 12 mo (**Figure**) are generally consistent with the unadjusted findings. After adjustment, among participants with reported opioid use at baseline, the predicted mean increase for those assigned to the intervention group was more than 1,200 steps over the two follow-up time points, as compared with a reduction of nearly 400 steps for those assigned to the usual care group (between-group difference = 1,625 steps, $p = 0.004$). Among nonopioid users, there was essentially no change in step counts in the intervention group and an increase of about 660 steps in the usual care group

Table 2.

Unadjusted changes in steps, pain, function, and opioid fills by baseline opioid use and intervention group. Data presented as *n* (%) or mean \pm standard deviation.

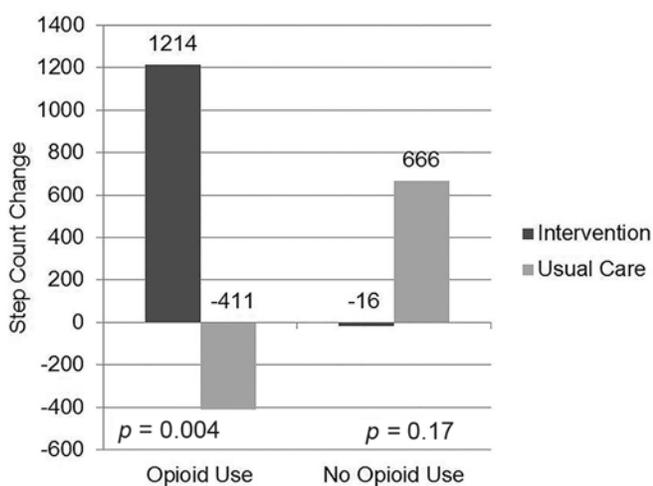
Variable	Reported Opioid Use			No Reported Opioid Use		
	Intervention (<i>n</i> = 44)	Usual Care (<i>n</i> = 55)	<i>p</i> -Value	Intervention (<i>n</i> = 64)	Usual Care (<i>n</i> = 58)	<i>p</i> -Value
Daily Step Counts						
Baseline	4,069.7 \pm 2,583.1	3,953.0 \pm 1,701.0	0.79	4,858.1 \pm 2,865.1	4,760.4 \pm 2,688.6	0.85
Difference (6 mo) ^{*†}	1,478.9 \pm 3,833.0	-153.5 \pm 1,599.7	0.03	400.2 \pm 3,182.6	91.7 \pm 3,760.6	0.68
Difference (12 mo) ^{*†}	1,087.4 \pm 2,889.6	-218.0 \pm 1,935.3	0.05	-359.0 \pm 2,519.4	154.3 \pm 1,861.1	0.31
Pain Severity (0–10)						
Baseline	6.5 \pm 1.6	6.2 \pm 1.7	0.41	5.7 \pm 1.9	5.9 \pm 1.6	0.37
Difference (6 mo) ^{*†}	-1.0 \pm 2.1	-0.43 \pm 1.7	0.14	-1.4 \pm 2.0	-1.1 \pm 1.7	0.51
Difference (12 mo) ^{*†}	-0.31 \pm 1.5	-0.18 \pm 1.8	0.72	-0.67 \pm 2.1	-0.86 \pm 1.6	0.61
RDQ Score (0–24)						
Baseline	10.4 \pm 5.5	10.5 \pm 6.2	0.91	8.2 \pm 5.9	9.1 \pm 5.1	0.37
Difference (6 mo) ^{*†}	-1.3 \pm 6.1	0.46 \pm 4.5	0.13	-2.2 \pm 5.6	-1.5 \pm 4.7	0.51
Difference (12 mo) ^{*†}	-2.6 \pm 7.8	-1.2 \pm 6.8	0.39	-1.6 \pm 5.7	-1.6 \pm 5.0	0.93
VA Fill for Opioid Medication in Prior 100 d						
Baseline	35/44 (80)	47/54 (87)	0.32	5/63 (8)	3/57 (5)	0.56
6 mo	24/43 (56)	34/54 (63)	0.48	8/60 (13)	11/55 (20)	0.35
12 mo	21/43 (49)	29/54 (54)	0.63	10/59 (17)	10/55 (18)	0.86

Note: *p*-values are based on *t*-tests or chi-square tests.

*All differences are calculated as follow-up minus baseline values, so negative values for pain severity and RDQ score indicate improvement.

†Number of subjects in each group varies over time due to nonresponse or loss to follow-up. Difference in daily step counts: among opioid users *n* = 30 intervention, *n* = 31 usual care at 6 mo and *n* = 30 intervention, *n* = 28 usual care at 12 mo; among nonopioid users *n* = 51 intervention, *n* = 36 usual care at 6 mo and *n* = 46 intervention, *n* = 36 usual care at 12 mo. Difference in survey derived measures (pain severity and RDQ score): among opioid users *n* = 40 intervention, *n* = 51 usual care at 6 mo and *n* = 39 intervention, *n* = 50 usual care at 12 mo; among nonopioid users *n* = 58 intervention, *n* = 50 usual care at 6 mo and *n* = 59 intervention, *n* = 49 usual care at 12 mo.

RDQ = Roland and Morris Back Pain Disability Questionnaire, VA = Department of Veterans Affairs.

**Figure.**

Six and twelve month adjusted average change in daily step counts from baseline by group.

(between-group difference = 683 steps, *p* = 0.17). The results after use of multiple imputations to account for missing data were similar (results not shown).

Table 2 shows unadjusted changes in pain severity, back-pain-related functional disability, and fills for opioid medications by study group at each time point. Most changes, in general, reflected improvements over time. Although not statistically significant, level of pain severity at 6 and 12 mo was lower for all of the study groups, with a larger reduction at 6 mo than at 12 mo. Except for those patients on opioids at baseline and in the usual care group who had an increase in average disability scores at 6 mo (by about 1/2 a point), all other patient subgroups reported less back-pain-related disability (lower RDQ scores) at both time points, with the greatest improvement reported by baseline opioid users in the intervention group at 12 mo (a difference of -2.6 from baseline). The percentage of patients with VA fills for opioid medications declined over time among those with reported opioid use

at baseline and increased slightly among the nonopioid users. However, the patterns in reported use (and opioid dose as shown in the [Appendix](#) [available online only]) were similar between intervention and usual care participants within each subgroup.

DISCUSSION

Managing chronic back pain is a significant challenge in the United States and worldwide [1,9]. Efforts to improve management of this prevalent condition are growing, fueled by concerns about the potential overuse and risks associated with opioid medications, coupled with the apparent underuse of other recommended options, such as exercise therapy and nonopioid medications [2,8–9,30]. To inform these efforts, we examined the effect of a walking intervention on average daily step counts among Veterans with chronic back pain that did and did not report opioid use. Our findings revealed a notable increase (>1,000 steps or approximately 1/2 mile a day) over the two follow-up time periods among study participants who were using opioids at baseline and who were assigned to the intervention group.

Specific reasons for this increase in walking activity are unknown but could be due in part to better pain relief and improved exercise tolerance. Indeed, this marked increase was not observed for intervention patients who did not report opioid use at baseline. In addition to studies that show improvements in measured exercise performance following acute opioid use [31–32], a multicenter study by Teske et al. [33] found that controlled-release oxycodone helped patients with movement pain engage in physical therapy. In our study, reported pain severity was lower at 6 and 12 mo compared with baseline for those who used opioids at baseline and who were assigned to the intervention group. Reductions in pain severity were also reported by other study participants; thus, the extent to which pain control might be related to the increased step counts is unclear. Nonetheless, this potential association between opioid use and objectively measured exercise performance, including specific mechanisms of action, such as pain reduction or increased tolerance, warrants additional study. Why the intervention appeared to be particularly helpful in increasing step counts among opioid users compared with nonopioid users is also a topic for further investigation.

Increased step counts, as a measure of function, are an important outcome in their own right. However, whether this increased activity is related to improvements in other important pain-related outcomes is also of interest. In general, our analysis showed a reduction in pain severity and back-pain-related disability over time across all study groups. Although there were no statistically significant differences within subgroups at 6 or 12 mo, participants with reported opioid use at baseline assigned to usual care had the least amount of improvement compared with the other groups. Some changes in VA opioid medication fills were also observed. Similar patterns, however, were observed in both the intervention and usual care groups and thus do not suggest any specific benefits related to the increase in steps found among the opioid users in the intervention group.

Perhaps one of the most important findings from this analysis is that patients receiving opioids were both willing and able to engage in walking to help manage their back pain, particularly when provided with additional support. Participants who reported opioid use at baseline and were assigned to the usual care group had basically no change in step counts during the 12 mo study period. Those assigned to the intervention, who received support in the form of walking goals, performance feedback, motivational messages, and social support, on the other hand, had a substantial increase that persisted over time. All too often clinicians may view patients who are on opioids as more recalcitrant and unlikely to use other pain management modalities. Similar to work by Fleming et al. [34], who found that complementary and alternative medicine was widely used by opioid users, our results show that opioid users may use walking to manage their back pain. This finding emphasizes the importance of supporting the use of alternative pain management strategies for patients with chronic back pain who are receiving opioids.

This study has some limitations. First, this is a secondary analysis of data collected as part of a randomized controlled trial. The interaction between baseline opioid use and the intervention was not a prespecified analysis and the study was not powered for a subgroup analysis of pain-related outcomes or service utilization. Nonetheless, we believe this is an important finding and warranted additional, even if somewhat preliminary, investigation. Second, there is a substantial amount of missing step count data. While this is a significant limitation, having objectively measured information on physical activity is

also a strength given the inherent unreliability of subjectively reported measures [35]. In addition, confidence in our main finding is enhanced through our use of multiple imputation procedures. Third, although the study sample consisted only of Veterans, we have no specific reason to suspect that the results would be substantially different with a non-Veteran population.

CONCLUSIONS

These limitations notwithstanding, our findings are important in the continuing quest for effective and safe treatment of chronic back pain. Our results suggest that use of opioid medications for chronic back pain could facilitate participation in walking as a form of exercise therapy, although this potential benefit must be balanced against the documented risks of opioid use. More importantly, these data show that patients receiving opioids may engage in walking to help manage their back pain when provided with additional support. Although more work is needed to determine the exact mechanisms of action and potential benefits associated with opioid use and walking as a form of exercise therapy, this study reinforces the importance of supporting the use of alternative pain management strategies for patients with chronic back pain who are receiving opioids.

ACKNOWLEDGMENTS

Author Contributions:

Responsible for data integrity and accuracy of analysis: S. L. Krein.

Study concept and design: S. L. Krein, A. Bohnert, H. M. Kim, M. E. Harris, C. R. Richardson.

Study analyses: S. L. Krein, H. M. Kim.

Drafting of manuscript: S. L. Krein, A. Bohnert, H. M. Kim, M. E. Harris, C. R. Richardson.

Critical revision of manuscript for important intellectual content:

S. L. Krein, A. Bohnert, H. M. Kim, M. E. Harris, C. R. Richardson.

Approval of final manuscript: S. L. Krein, A. Bohnert, H. M. Kim, M. E. Harris, C. R. Richardson.

Financial Disclosures: The authors have declared that no competing interests exist.

Funding/Support: This material was based on work supported by the VA Health Services Research and Development Service (award IIR 07–177). The study sponsors had no role in the design or conduct of the study; the collection, management, analysis, and interpretation of the data; or the preparation, review, or approval of the manuscript.

Additional Contributions: The authors would like to thank Reema Kadri, Maria Hughes, Tabitha Metreger, and Rob Holleman for their

assistance with data collection and management during the course of the study.

Institutional Review: The study protocol was approved by the VA Ann Arbor Healthcare System Institutional Review Board. Written informed consent was provided by all study participants.

Participant Follow-Up: We are not able to inform the study participants regarding publication of the article since in accordance with our human studies protection plan we have deidentified all study data and no longer have access to participant contact information.

Disclaimer: The views expressed in this article are those of the authors and do not necessarily reflect the position or policy of the VA or the U.S. Government.

REFERENCES

1. Institute of Medicine. Relieving pain in America: A blueprint for transforming prevention, care, education, and research. Washington (DC): The National Academies Press; 2011.
2. Gore M, Tai KS, Sadosky A, Leslie D, Stacey BR. Use and costs of prescription medications and alternative treatments in patients with osteoarthritis and chronic low back pain in community-based settings. *Pain Pract*. 2012;12(7):550–60. [PMID:22304678] <http://dx.doi.org/10.1111/j.1533-2500.2012.00532.x>
3. Alexander GC, Kruszewski SP, Webster DW. Rethinking opioid prescribing to protect patient safety and public health. *JAMA*. 2012;308(18):1865–66. [PMID:23150006] <http://dx.doi.org/10.1001/jama.2012.14282>
4. Mitchinson AR, Kerr EA, Krein SL. Management of chronic noncancer pain by VA primary care providers: When is pain control a priority? *Am J Manag Care*. 2008;14(2):77–84. [PMID:18269303]
5. Butchart A, Kerr EA, Heisler M, Piette JD, Krein SL. Experience and management of chronic pain among patients with other complex chronic conditions. *Clin J Pain*. 2009;25(4):293–98. [PMID:19590477] <http://dx.doi.org/10.1097/AJP.0b013e31818bf574>
6. Gironda RJ, Clark ME, Massengale JP, Walker RL. Pain among veterans of Operations Enduring Freedom and Iraqi Freedom. *Pain Med*. 2006;7(4):339–43. [PMID:16898945] <http://dx.doi.org/10.1111/j.1526-4637.2006.00146.x>
7. Sinnott P, Wagner TH. Low back pain in VA users. *Arch Intern Med*. 2009;169(14):1338–39, author reply 1339. [PMID:19636039] <http://dx.doi.org/10.1001/archinternmed.2009.201>
8. Chou R, Huffman LH; American Pain Society; American College of Physicians. Nonpharmacologic therapies for acute and chronic low back pain: A review of the evidence for an American Pain Society/American College of Physicians clinical practice guideline. *Ann Intern Med*. 2007;

- 147(7):492–504. [PMID:17909210]
<http://dx.doi.org/10.7326/0003-4819-147-7-200710020-00007>
9. Mafi JN, McCarthy EP, Davis RB, Landon BE. Worsening trends in the management and treatment of back pain. *JAMA Intern Med.* 2013;173(17):1573–81. [PMID:23896698]
<http://dx.doi.org/10.1001/jamainternmed.2013.8992>
10. Piccoliori G, Engl A, Gatterer D, Sessa E, in der Schmitten J, Abholz HH. Management of low back pain in general practice—is it of acceptable quality: An observational study among 25 general practices in South Tyrol (Italy). *BMC Fam Pract.* 2013;14:148. [PMID:24090155]
<http://dx.doi.org/10.1186/1471-2296-14-148>
11. Deyo RA, Smith DH, Johnson ES, Donovan M, Tillotson CJ, Yang X, Petrik AF, Dobscha SK. Opioids for back pain patients: Primary care prescribing patterns and use of services. *J Am Board Fam Med.* 2011;24(6):717–27. [PMID:22086815]
<http://dx.doi.org/10.3122/jabfm.2011.06.100232>
12. Martell BA, O'Connor PG, Kerns RD, Becker WC, Morales KH, Kosten TR, Fiellin DA. Systematic review: opioid treatment for chronic back pain: prevalence, efficacy, and association with addiction. *Ann Intern Med.* 2007;146(2):116–27. [PMID:17227935]
<http://dx.doi.org/10.7326/0003-4819-146-2-200701160-00006>
13. Gwira Baumblatt JA, Wiedeman C, Dunn JR, Schaffner W, Paulozzi LJ, Jones TF. High-risk use by patients prescribed opioids for pain and its role in overdose deaths. *JAMA Intern Med.* 2014;174(5):796–801. [PMID:24589873]
<http://dx.doi.org/10.1001/jamainternmed.2013.12711>
14. Chaparro LE, Furlan AD, Deshpande A, Mailis-Gagnon A, Atlas S, Turk DC. Opioids compared with placebo or other treatments for chronic low back pain: An update of the Cochrane Review. *Spine (Phila Pa 1976).* 2014;39(7):556–63. [PMID:24480962]
<http://dx.doi.org/10.1097/BRS.0000000000000249>
15. Alford DP. Chronic back pain with possible prescription opioid misuse. *JAMA.* 2013;309(9):919–25. [PMID:23462788]
<http://dx.doi.org/10.1001/jama.2013.522>
16. Bohnert AS, Valenstein M, Bair MJ, Ganoczy D, McCarthy JF, Ilgen MA, Blow FC. Association between opioid prescribing patterns and opioid overdose-related deaths. *JAMA.* 2011;305(13):1315–21. [PMID:21467284]
<http://dx.doi.org/10.1001/jama.2011.370>
17. Chaparro LE, Furlan AD, Deshpande A, Mailis-Gagnon A, Atlas S, Turk DC. Opioids compared to placebo or other treatments for chronic low-back pain [review]. *Cochrane Database Syst Rev.* 2013;8(8):CD004959. [PMID:23983011]
<http://dx.doi.org/10.1002/14651858.CD004959.pub4>
18. Kissin I. Long-term opioid treatment of chronic nonmalignant pain: Unproven efficacy and neglected safety? *J Pain Res.* 2013;6:513–29. [PMID:23874119]
<http://dx.doi.org/10.2147/JPR.S47182>
19. Hayden JA, van Tulder MW, Malmivaara AV, Koes BW. Meta-analysis: Exercise therapy for nonspecific low back pain. *Ann Intern Med.* 2005;142(9):765–75. [PMID:15867409]
<http://dx.doi.org/10.7326/0003-4819-142-9-200505030-00013>
20. van Middelkoop M, Rubinstein SM, Kuijpers T, Verhagen AP, Ostelo R, Koes BW, van Tulder MW. A systematic review on the effectiveness of physical and rehabilitation interventions for chronic non-specific low back pain. *Eur Spine J.* 2011;20(1):19–39. [PMID:20640863]
<http://dx.doi.org/10.1007/s00586-010-1518-3>
21. Krein SL, Metreger T, Kadri R, Hughes M, Kerr EA, Piette JD, Kim HM, Richardson CR. Veterans walk to beat back pain: Study rationale, design and protocol of a randomized trial of a pedometer-based internet mediated intervention for patients with chronic low back pain. *BMC Musculoskelet Disord.* 2010;11:205. [PMID:20836856]
<http://dx.doi.org/10.1186/1471-2474-11-205>
22. Krein SL, Kadri R, Hughes M, Kerr EA, Piette JD, Holleman R, Kim HM, Richardson CR. Pedometer-based internet-mediated intervention for adults with chronic low back pain: Randomized controlled trial. *J Med Internet Res.* 2013;15(8):e181. [PMID:23969029]
<http://dx.doi.org/10.2196/jmir.2605>
23. Zhu W, Lee M. Invariance of wearing location of Omron-BI pedometers: A validation study. *J Phys Act Health.* 2010;7(6):706–17. [PMID:21088300]
24. Andresen EM, Malmgren JA, Carter WB, Patrick DL. Screening for depression in well older adults: Evaluation of a short form of the CES-D (Center for Epidemiologic Studies Depression Scale). *Am J Prev Med.* 1994;10(2):77–84. [PMID:8037935]
25. Mularski RA, White-Chu F, Overbay D, Miller L, Asch SM, Ganzini L. Measuring pain as the 5th vital sign does not improve quality of pain management. *J Gen Intern Med.* 2006;21(6):607–12. [PMID:16808744]
<http://dx.doi.org/10.1111/j.1525-1497.2006.00415.x>
26. Roland M, Morris R. A study of the natural history of back pain. Part I: Development of a reliable and sensitive measure of disability in low-back pain. *Spine (Phila Pa 1976).* 1983;8(2):141–44. [PMID:6222486]
<http://dx.doi.org/10.1097/00007632-198303000-00004>
27. Lorig K, Stewart A, Ritter P, Gonzalez V, Laurent D, Lynch J. Outcome measures for health education and other health care interventions. Thousand Oaks (CA): Sage Publications; 1996.
28. Little RJ, Rubin DB. Statistical analysis with missing data. New York (NY): Wiley; 1987.

29. Schofferman J, Mazanec D. Evidence-informed management of chronic low back pain with opioid analgesics. *Spine J*. 2008;8(1):185–94. [PMID:18164466] <http://dx.doi.org/10.1016/j.spinee.2007.10.020>
30. Nuckols TK, Anderson L, Popescu I, Diamant AL, Doyle B, Di Capua P, Chou R. Opioid prescribing: A systematic review and critical appraisal of guidelines for chronic pain. *Ann Intern Med*. 2014;160(1):38–47. [PMID:24217469] <http://dx.doi.org/10.7326/0003-4819-160-1-201401070-00732>
31. Rashaq S, Koller M, Haykowsky M, Jamieson K. The effect of opioid analgesia on exercise test performance in chronic low back pain. *Pain*. 2003;106(1–2):119–25. [PMID:14581118] [http://dx.doi.org/10.1016/S0304-3959\(03\)00299-9](http://dx.doi.org/10.1016/S0304-3959(03)00299-9)
32. Gross DP, Bhambhani Y, Haykowsky MJ, Rashaq S. Acute opioid administration improves work-related exercise performance in patients with chronic back pain. *J Pain*. 2008;9(9):856–62. [PMID:18562250] <http://dx.doi.org/10.1016/j.jpain.2008.04.006>
33. Teske W, Anastasiadis A, Krämer J, Theodoridis T. [Effective pain relief facilitates exercise therapy: Results of a multicenter study with controlled-release oxycodone in patients with movement pain]. *Orthopade*. 2008;37(12):1210–16. German. [PMID:18806997] <http://dx.doi.org/10.1007/s00132-008-1344-z>
34. Fleming S, Rabago DP, Mundt MP, Fleming MF. CAM therapies among primary care patients using opioid therapy for chronic pain. *BMC Complement Altern Med*. 2007;7:15. [PMID:17506893] <http://dx.doi.org/10.1186/1472-6882-7-15>
35. Strath SJ, Kaminsky LA, Ainsworth BE, Ekelund U, Freedson PS, Gary RA, Richardson CR, Smith DT, Swartz AM; American Heart Association Physical Activity Committee of the Council on Lifestyle and Cardiometabolic Health and Cardiovascular, Exercise, Cardiac Rehabilitation and Prevention Committee of the Council on Clinical Cardiology, and Council. Guide to the assessment of physical activity: Clinical and research applications: a scientific statement from the American Heart Association. *Circulation*. 2013;128(20):2259–79. [PMID:24126387] <http://dx.doi.org/10.1161/01.cir.0000435708.67487.da>

Submitted for publication August 18, 2014. Accepted in revised form December 10, 2014.

This article and any supplementary material should be cited as follows:

Krein SL, Bohnert A, Kim HM, Harris ME, Richardson CR. Opioid use and walking among patients with chronic low back pain. *J Rehabil Res Dev*. 2016;53(1):107–16. <http://dx.doi.org/10.1682/JRRD.2014.08.0190>

ORCID: Sarah L. Krein, PhD, RN: 0000-0003-2111-8131



