OBJECTIVE. We examined whether tailored activity pacing intervention was more effective at reducing pain and fatigue than general activity pacing intervention.

METHOD. Adults with knee or hip osteoarthritis ($N = 32$) stratified by age and gender were randomized to receive either tailored or general pacing intervention. Participants wore an accelerometer for 5 days that measured physical activity and allowed for repeated symptom assessment. Physical activity and symptom data were used to tailor activity pacing instruction. Outcomes at 10-week follow-up were pain (Western Ontario and McMaster Universities Osteoarthritis Index) and fatigue (Brief Fatigue Inventory).

RESULTS. Compared with general intervention, the tailored group had less fatigue interference ($p = .02$) and trended toward decreased fatigue severity ($p = .09$) at 10-wk follow-up. No group differences were found in pain reduction.

CONCLUSION. Tailoring instruction on the basis of recent symptoms and physical activity may be a more effective symptom management approach than general instruction given the positive effects on fatigue.


Arthritis affects approximately 43 million adults and is a leading cause of disability in the United States (Centers for Disease Control and Prevention, 2001; Hootman et al., 2005). Osteoarthritis (OA), the most common form of arthritis, typically affects the knee and hip joints and causes symptoms that are associated with mobility impairment, decreased physical activity, and reduced quality of life. Often people with OA receive pharmacological treatments to alleviate pain; however, a combination of pharmacological and non-pharmacological treatments is considered optimal for OA management (Zhang et al., 2007).

Nonpharmacological treatments, when offered within the context of clinical care, are usually provided by physical and occupational therapists and typically include exercise training, splinting, and adaptive equipment. Those interventions, however, often do not directly address the broader issue of how symptoms affect participation in daily activities, a common source of struggle for people with OA (Leveille et al., 2001).

Activity pacing is a strategy that occupational therapists commonly use to address symptoms that interfere with activity engagement in patients with chronic pain (Brown, 2002). Instruction in activity pacing is believed to help alter inefficient activity patterns such as being overactive with prolonged inactive periods or being underactive, both of which can lead to impaired physical
we found individual variation in the types and patterns of physical activity over a series of days. Daily routines by the real-time recording of symptoms can reconstruct a picture of a person’s participation in activities. With wrist-worn accelerometers and a user input button, we believe this method will be of particular benefit to adults with OA. Using enhanced activity patterns based on individual activity and symptom patterns would offer the potential to target for intervention. We believe that using a tailored activity pacing approach that is relevant and to promote long-term behavior change. We believe that using a tailored approach to activity pacing based on individual symptom and physical activity patterns is needed to have symptomatic knee or hip OA in at least one joint as evidenced by self-reported joint pain for at least 3 mo, a pain score of ≥4 of the five items on the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC; Bellamy, Buchanan, Goldsmith, Campbell, & Stitt, 1988). Pain subscale with two items rated moderate pain or more (Goggins, Baker, & Felson, 2005), and radiographic evidence of OA in that joint (≥2 on the Kellgren Lawrence scale; Kellgren & Lawrence, 1957). People were excluded if they were nonambulatory, had medical conditions or problems other than OA that interfered with daily activity performance or caused pain (e.g., cardiopulmonary problems, neurological conditions, autoimmune diseases), had a joint replacement or surgery of the knee or hip in the previous 6 mo, were undergoing current OA treatment (other than pharmacological treatment) to reduce symptoms (e.g., physical or occupational therapy or cortisone injections), or were unable to operate the accelerometer used in this study.

Method

Sample

Potential participants responded to public advertisements in the southeast Michigan area. On the basis of an initial telephone screening, eligible adults signed consent forms from the University of Michigan Institutional Review Board and underwent X-rays of their hips or knees to determine the presence and severity of OA. Participants were eligible for the study if they were between ages 50 and 80, had a score of ≥26 on the Mini-Mental State Exam (Folstein, Folstein, & McHugh, 1975), and were English speaking. Participants also needed to have symptomatic knee or hip OA in at least one joint as evidenced by self-reported joint pain for at least 3 mo, a pain score of ≥4 of the five items on the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC; Bellamy, Buchanan, Goldsmith, Campbell, & Stitt, 1988). Pain subscale with two items rated moderate pain or more (Goggins, Baker, & Felson, 2005), and radiographic evidence of OA in that joint (≥2 on the Kellgren Lawrence scale; Kellgren & Lawrence, 1957). People were excluded if they were nonambulatory, had medical conditions or problems other than OA that interfered with daily activity performance or caused pain (e.g., cardiopulmonary problems, neurological conditions, autoimmune diseases), had a joint replacement or surgery of the knee or hip in the previous 6 mo, were undergoing current OA treatment (other than pharmacological treatment) to reduce symptoms (e.g., physical or occupational therapy or cortisone injections), or were unable to operate the accelerometer used in this study.

A tailored approach to interventions is increasingly being recommended to make the content personally relevant and to promote long-term behavior change. We believe that using a tailored activity pacing approach that is based on individual activity and symptom patterns would be of particular benefit to adults with OA. Using enhanced wrist-worn accelerometers with a user input button, we can reconstruct a picture of a person’s participation in daily routines by the real-time recording of symptoms and physical activity over a series of days. Our previous studies support a tailored approach. First, we found individual variation in the types and patterns of pain and fatigue symptoms experienced over time (Murphy, Smith, Clauw, & Alexander, 2008). Second, we found that fatigue in participants with OA was more severe and more strongly associated with physical activity levels than pain, which suggests that fatigue may also be important to target for intervention (Murphy, Smith, Clauw, et al., 2008). Third, we found that the natural use of activity pacing (before instruction) was largely a reactionary response to symptom severity rather than a preplanned strategy (Murphy, Smith, & Alexander, 2008). The purpose of this study was to examine whether an intervention tailored to individual symptom and physical activity patterns recorded during a home-monitoring period would be more effective at managing pain and fatigue than general instruction about how to use activity pacing as a symptom management tool.
Our main data collection periods were at baseline and at 10-wk follow-up. We also collected data immediately after the intervention (approximately 4 wk after baseline); however, those data were collected only to examine potential mechanisms of therapeutic change. We did not believe that application of the techniques and advice from the therapists could be adequately integrated into daily routines immediately after the intervention. At the baseline visit, demographic and health status information were collected, and physical performance tests were completed. All participants were then instructed on wearing an accelerometer on their nondominant wrist during the 5-day home-monitoring period. The accelerometer measured physical activity, and participants were asked to track their symptoms and activity pacing behaviors 6 times per day (wake up, 2 hr after waking, 4 hr after waking, 8 hr after waking, 12 hr after waking, and 30 min before bed) by entering their responses into the accelerometer. Participants were also instructed on how to record responses in a log book. The log book was used to record daily activities in addition to wake-up and bed times each day.

After the home-monitoring period, participants returned the accelerometer and log book and began the intervention within the week. At posttest and at 10-wk follow-up, participants wore the accelerometer for a 5-day home-monitoring period and completed questionnaires. The 10-wk follow-up period also included a lab visit in which participants completed physical performance tests. All testing was done by assessors who were blinded to the group assignment of participants.

### Activity Pacing Interventions

Thirty-two adults with symptomatic hip or knee OA stratified by age and gender were randomized into the tailored or the general activity pacing intervention group. Randomization was done by generating a randomized schedule using SAS software (SAS Institute, Inc., Cary, NC) in which participants were assigned to the tailored or general activity pacing groups on the basis of whether they were “young” or “old” (using a cut-off age that was the mean age The PI was the first author (SM) of participants in a previous study; Murphy, Smith, Clauw, et al., 2008) and on gender. The principal investigator (Susan Murphy) was blinded to participant assignment. Regardless of group assignment, all participants met with an occupational therapist for two one-on-one sessions (total treatment time: 1.5 hr) over a 2-wk period.

At the first session, both groups received a study-specific education module on activity pacing. In the general intervention group, the occupational therapist discussed the general principles of activity pacing (i.e., preplanning activities, alternating activity with rest before a symptom exacerbation) with a recommendation to implement the strategies over the subsequent few days. In the tailored group, the occupational therapist tailored recommendations on the basis of a personalized report that detailed the relationship between activity and symptoms using graphs and bulleted points. Although the tailored group also received the education module, the report was the focus of the intervention. For both interventions, the first session focused on education on activity pacing (either tailored or general), whereas the second session focused on individual progress with activity pacing and addressed barriers to using the recommended strategies.

### Measures

The primary outcome measures were pain and fatigue. Although momentary pain and fatigue were assessed by entering those ratings into the accelerometer, we chose recall-based measures of symptoms as our primary symptom measures to reduce the possibility of a group bias in momentary symptom reporting (i.e., the tailored group was given information about their momentary symptoms during treatment). Pain was measured by means of the WOMAC, a validated, disease-specific questionnaire (Bellamy et al., 1988). The Pain subscale has a scale of 0–20 in which a higher number indicates more pain. Fatigue was measured using the Brief Fatigue Inventory (BFI; Mendoza et al., 1999). The 10-item scale has been validated in cancer patients, and among these samples, a general severity score based on an average of 9 items is used. In rheumatology samples, two fatigue subscales of the BFI (Fatigue Severity and Fatigue Interference) have been used (Wolfe, 2004). Because we were interested in fatigue as a multidimensional construct, particularly with respect to the degree of interference with daily activities, we chose to analyze our data using these subscales.

Other measures collected were assessments of physical function and physical activity. Physical function was measured by two common, validated measures: the Six-Minute Walk Test (Butland, Pang, Gross, Woodcock, & Geddes, 1982) and the Timed Up and Go Test (Podsiadlo & Richardson, 1991). Physical activity was measured by a wrist-worn accelerometer (Actiwatch-Score, Mini-Mitter Phillips Respironics, Bend, OR) over the 5-day home-monitoring period. The Actiwatch-Score contains a piezoelectrode that records movements of >0.01 g force (g), a level of force that is sensitive to minute movements. Movement is sampled 32 times/s, and the peak value is
added to an accumulated value over a 15-s epoch period, which is recorded as an activity count. Total physical activity was calculated by averaging the cumulative daytime activity counts over 5 days. Peak physical activity was calculated by averaging the largest activity count each day over the 5-day period. The Actiwatch-Score worn at the wrist has been shown to have excellent reliability between units ($r = .98$) and has established preliminary criterion validity among a sample of chronic pain patients (Gironda, Lloyd, Clark, & Walker, 2007).

**Data Analysis**

To examine baseline differences between groups, we calculated each group’s means and performed independent sample $t$ tests. General linear models were used to examine group differences in pain and fatigue from baseline to 10-wk follow-up. In the general linear models, the outcome variables were WOMAC Pain, BFI Fatigue Severity, and BFI Fatigue Interference; we controlled for age and gender. The main effect is time, and the interaction of interest is Time $\times$ Group. Because the small sample size likely affects the power to detect small to moderate effects, the effect size $d$ (Cohen, 1988) is also presented for these analyses. The magnitude of $d$ has been described as $0.2 = \text{small}$, $0.5 = \text{moderate}$, and $0.8 = \text{large}$ (Cohen, 1988).

**Results**

Of the 178 people screened by phone for eligibility, 57% were ineligible because they did not meet the study criteria, we were unable to recontact them, or they lacked interest (Figure 1). Of those who proceeded through X-ray screening, 38% were ineligible because they did not have OA $\geq 2$ on the Kellgren Lawrence scale, and 7% were either not interested or withdrew. Twenty-four percent of the people originally phone screened ($n = 42$) were randomized into either the tailored or the general intervention group. Six participants withdrew from the general intervention group, and 4 participants from the tailored group either withdrew ($n = 2$) or were our first pilot participants ($n = 2$), who participated only to test intervention delivery and our ability to generate the individualized reports.

Of the 32 participants, 75% were women, and the mean age was 61.9 ± 7.9 yr. Two-thirds of the sample had radiographic evidence of knee OA, and one-third had radiographic hip OA. With respect to race, 25 participants were White (78%), 6 were African-American (19%), and 1 was a Pacific Islander (3%). Most participants had at least some college education (28/30), and most participants worked at least part time (26/30).

Table 1 shows characteristics by group. No statistically significant group differences were found. Participants in the tailored intervention group tended to be slightly older (64 vs. 60 yr), although the difference did not reach significance ($p = .10$). Participants in both groups were similar in terms of baseline physical function and physical activity. Daily pain medication use by group was similar over the 5-day home-monitoring period. Three people in each group reported occasional narcotic (e.g., hydrocodone) or narcoticlike (e.g., tramadol) drug use for pain during the 5-day period. Between the general intervention and tailored groups, no significant differences in baseline levels of BFI fatigue severity ($4.6 \pm 2.3$ and $4.1 \pm 1.9$, respectively, $p = .52$) or fatigue interference ($4.2 \pm 2.9$ and $3.2 \pm 2.2$ respectively, $p = .27$) were found. Baseline pain severity on the WOMAC was higher in the general intervention group (10.2 ± 3.9) than in the tailored group (7.9 ± 3.8), a result that did not reach statistical significance ($p = .10$).

Table 2 shows general linear models in which we examined changes in WOMAC Pain, BFI Fatigue Severity, and BFI Fatigue Interference. For the WOMAC Pain measure, both groups reported decreased pain at 10-wk follow-up, but no significant time effects or Time $\times$ Group effects were found. A small effect size was
found \((d = 0.38)\). Fatigue severity on the BFI did not significantly differ by group at 10-wk follow-up; however, there was a trend toward a greater decrease in the tailored group \((F[1, 21] = 3.27, p = .09)\), and there was a moderate-to-large effect size for this group difference \((d = 0.79)\). Fatigue interference on the BFI decreased more in the tailored activity pacing group than in the general intervention group \((F[1, 21] = 6.36, p = .02)\), and a large effect size for this group difference was found \((d = 1.10)\). For this statistical model, our test of homogeneity revealed different group variances because of large improvements in the tailored group; these improvements caused a floor effect. Although the \(F\) test is generally robust to moderate deviations of equal variances, we adjusted the \(\alpha\) level to the more stringent level of .025 to account for this lack of homogeneity. Even with the more stringent \(\alpha\) level, the effect was still significant.

### Table 1. Group Characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>General Intervention ((n = 15))</th>
<th>Tailored Intervention ((n = 17))</th>
<th>(p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female, (n(%)^a)</td>
<td>11 (73)</td>
<td>13 (76)</td>
<td>.57</td>
</tr>
<tr>
<td>Age, yr</td>
<td>59.5 6.6</td>
<td>63.9 7.8</td>
<td>.10</td>
</tr>
<tr>
<td>BMI, kg/m(^2)</td>
<td>31.8 6.0</td>
<td>32.7 7.2</td>
<td>.59</td>
</tr>
<tr>
<td>Daily pain medication use(^b)</td>
<td>7.2 8.0</td>
<td>7.1 8.2</td>
<td>.98</td>
</tr>
<tr>
<td>Depression (GDS)</td>
<td>1.9 1.8</td>
<td>2.4 2.8</td>
<td>.56</td>
</tr>
<tr>
<td>TUG, s</td>
<td>10.3 2.7</td>
<td>10.3 2.0</td>
<td>.97</td>
</tr>
<tr>
<td>6-min walk, ft</td>
<td>1,203.0 257.0</td>
<td>1,120.0 295.0</td>
<td>.40</td>
</tr>
<tr>
<td>Total physical activity(^b)</td>
<td>325,528.3 79,407.5</td>
<td>336,831.5 91,435.4</td>
<td>.71</td>
</tr>
<tr>
<td>Peak physical activity(^b)</td>
<td>941.5 192.6</td>
<td>911.7 249.8</td>
<td>.71</td>
</tr>
<tr>
<td>WOMAC pain</td>
<td>10.2 3.9</td>
<td>7.9 3.8</td>
<td>.10</td>
</tr>
<tr>
<td>BFI fatigue severity</td>
<td>4.6 2.3</td>
<td>4.1 1.9</td>
<td>.52</td>
</tr>
<tr>
<td>BFI fatigue interference</td>
<td>4.2 2.9</td>
<td>3.2 2.2</td>
<td>.27</td>
</tr>
</tbody>
</table>

Note. Unless otherwise indicated, means (\(M\)) and standard deviations (\(SD\)) are presented. BMI = body mass index; GDS = Geriatric Depression Scale (Yesavage et al., 1983); BFI = Brief Fatigue Inventory; WOMAC = Western Ontario and McMaster Arthritis Index; TUG = Timed Up & Go Test.

\(^a\)Because of low cell counts, Fisher’s exact test was used.

\(^b\)Daily average over the 5-day home-monitoring period.

### Clinical Example

To illustrate the tailoring of activity pacing instruction, Figure 2 shows the physical activity and momentary fatigue at baseline and at 10-wk follow-up of a 76-yr-old man. At baseline, this participant had fatigue that fluctuated throughout the day and was more severe than pain levels. Fatigue was also associated with bouts of physically demanding activities (e.g., carrying loads and doing yard work). We used the accelerometer data to examine activity peaks relative to increases in symptoms and to generate an individualized report. The report summarized the symptom and activity patterns and provided person-specific recommendations such as distributing more physically demanding activities throughout the week rather than trying to complete them all in a single day. Examples of recommendations included (1) planning for a bout of yard work or housework on a day that did not also involve being involved in child care activities, (2) incorporating...
short rest breaks (5–10 min) for every 30–60 min of activity, and (3) increasing the frequency of breaks earlier in the day to avoid evening symptom flares. At 10-wk follow-up, fatigue was less severe over the 5-day monitoring period, and it was less variable. Although there was a decrease in total daily physical activity at 10-wk follow-up, there was a more sustained activity pattern rather than a series of peaks followed by increased symptoms and extended rest periods. The daily activity log and the accelerometer data indicated that the participant distributed physically demanding activities throughout the week and tried to minimize doing several demanding activities on the same day as a child care day. The 10-wk follow-up data also showed that although daily fluctuations in fatigue decreased, an increase in fatigue severity was seen on Day 5, suggesting another clinical issue for discussion with the participant. Although the intervention ended before this data collection period, it may be optimal to have several home-monitoring sessions on which to base interventions to help the participant improve or refine symptom management strategies.

Discussion

This pilot study evaluated the effectiveness of a tailored activity pacing intervention for symptom management among people with knee and hip OA. We found that the participants in the tailored activity pacing group, compared with the general intervention group members, reported that fatigue had less of an impact on their daily life at 10-wk follow-up ($d = 1.10$) and that fatigue severity had decreased ($d = 0.79$). The large effect sizes, coupled with the statistically significant finding for fatigue interference ($p = .02$) and the trend toward significance for fatigue severity ($p = .09$), suggest that the lack of statistical significance for the severity measure may be an artifact of the small sample size.

We did not find an effect on pain reduction for the tailored activity pacing group compared with the general intervention group. Although not statistically significant, age- and gender-adjusted models suggest that both groups reported decreased pain from baseline to 10-wk follow-up.
(F[1, 24] = 0.09, p = .77). This difference reached statistical significance in unadjusted models (F[1, 23] = 12.99, p = .002), suggesting a possible effect of participating in either intervention on pain reduction—although the lack of a no-treatment control group complicates interpretation of this finding. A larger future study can further explore this issue.

Given that the tailored intervention was designed to target problematic symptoms from the home-monitoring period, it is not surprising that fatigue was most greatly affected in the tailored activity pacing intervention. In our previous work, we showed that momentary fatigue was higher, more variable, and more strongly associated with physical activity levels than was momentary pain for people with knee or hip OA (Murphy, Smith, Clauw, et al., 2008). Therefore, fatigue may have been discussed more often or to a greater extent than pain in the tailored intervention. Although fatigue was discussed in the general intervention group, it appears that the tailored activity pacing approach was needed to positively affect fatigue.

Although this pilot study needs to be replicated with a larger sample, the results are promising and demonstrate a potential method to deliver a targeted symptom management intervention for people with knee or hip OA. The use of wrist-worn accelerometers to measure within-day symptoms and physical activity and the corresponding log books provide a comprehensive picture of a person’s participation in daily routines. These data are collected in a home-monitoring period and can be synthesized for therapists into reports; therefore, the intervention can potentially have a powerful impact because it is tailored and can be delivered in a health care setting in a limited number of sessions. Although there was a time burden for our research staff to generate reports from the data (approximately 1 hr per report), we could potentially reduce this time by working with the accelerometer software company to generate the desired graphics for reports. This collaboration has taken place successfully using these types of data in a cognitive–behavioral therapy intervention for people with insomnia (Loewy, 2009). The clinical example provided in the Results section is an example of tailoring for symptom management in this study. Occupational therapists have the requisite knowledge in occupational performance to tailor symptom management interventions in this way.

The small sample size of this pilot study limits our ability to generalize the findings. Our analyses were conducted only on participants with 10-wk follow-up data, which does not take into account data on 7 participants. Because of the small group sizes, we were unable to conduct intent-to-treat analyses to take this factor into account. In addition, in studies such as this, the possibility of a “therapist” effect exists, in which one therapist could be more effective in his or her administration of an intervention than the other therapist. A larger study should include more than one therapist per intervention arm. In this pilot study, we controlled for other potential therapist effects by blinding them to the study hypotheses and separating them from the data collection process.

Further research should examine the lasting effects of this type of symptom management intervention and explore the characteristics of participants who best respond to this approach. In addition, a larger study should be designed to measure the impact of treatment versus no treatment by including a control group, which is also needed to examine the natural progression of symptoms and physical activity in people with OA. On the basis of the feedback from the therapists who conducted the intervention, we also feel that it may be important to add another treatment session to both intervention groups. For the tailored intervention group, barriers to activity pacing were often discussed in the second session, but there was no chance to revisit those barriers because the intervention ended at that point. A third session may be necessary to have adequate time to practice symptom management strategies once barriers are identified.

Conclusion

This study provides preliminary support for the effectiveness of an occupational therapist–delivered activity pacing intervention tailored to symptom and activity patterns on reducing fatigue in adults with OA. Future research to replicate and extend the findings in larger studies is needed. Given that fatigue is an important clinical symptom in knee and hip OA, interventions such as the one reported here will be needed to address this growing public health problem.

Acknowledgments

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