The Unique and Transient Impact of Acute Exercise on Pain Perception in Older, Overweight, or Obese Adults With Knee Osteoarthritis

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ABSTRACT

This study examined the unique contribution of acute exercise to perceptions of pain in 32 older, overweight, or obese adults with knee osteoarthritis (OA), statistically controlling for the effect of diurnal variation, supplemental medication intake, and stress. Using an ecological momentary assessment method, 964 pain appraisals were recorded and coded into experience samplings that occurred either on a nonexercise day or before or following scheduled activity on an exercise day. Univariate and multivariate multilevel modeling analyses controlling for supplemental medication intake and stress revealed a quadratic trend in diurnal pain variations with the peak occurring mid-afternoon. Although pain was significantly elevated following exercise in comparison with the predicted diurnal pattern, pain reports later in the day following exercise were significantly lower than immediately following exercise. We conclude that the pain associated with acute exercise by older, overweight, or obese adults who have knee OA is transient. Findings are discussed in terms of the implications of exercise therapy for patients with knee OA.


INTRODUCTION

Pain resulting from knee osteoarthritis (OA) has a profound impact on health-related quality of life in older adults (1,2), an effect that is compounded by obesity (3). Notably, pain levels associated with knee OA have been found to be inversely related to psychological well-being and participation in physical activity (4–6). Because there is no cure for this disease, current medical practice focuses on interventions to reduce the progression of the disease and the negative impact it has on health-related quality of life (7). In this regard, exercise training programs (e.g., chronic exercise) have been found to have a beneficial effect on pain symptoms (6,8–10). Unfortunately, although chronic exercise has been associated with reductions in pain, clinical evidence indicates that single episodes of exercise (i.e., acute exercise) may exacerbate pain symptoms associated with knee OA (11). Furthermore, although diurnal cycles in chronic pain have been reported previously (12–14), the potential impact of circadian variations on pain responses to acute exercise in patients with knee OA has yet to be delineated. Similarly, it is not known whether physical exercise and diurnal variations explain variance in pain reports above and beyond what might be explained by factors such as supplemental medication use and psychosocial stress. Thus, our objective was to examine the influence of acute exercise on the perception of pain in older, overweight, or obese adults with symptomatic knee OA, statistically controlling for variations caused by diurnal trends, supplemental medication use, and psychosocial stress.

Acute Exercise and Pain Perception

In recent years, there has been a proliferation of research examining the role of acute exercise on pain perception in healthy individuals (15). Within this line of inquiry, mounting evidence suggests that acute bouts of exercise are associated with improvements in the perception of experimentally induced pain. For example, single bouts of exercise have been associated with elevations in pain threshold and reductions in pain ratings during exposure to a variety of noxious external stimuli including dental pulp stimulation (16–18), thermal stimulation (19), and pressure pain stimuli (20–22). It is important to note, however, that exercise-induced analgesia has only been consistently observed following bouts of exercise performed at or above 75% of maximal aerobic capacity (22). Hence, improvements in the perception of pain following acute exercise may be moderated by the dose of activity.

Although acute exercise has been consistently found to reduce the perception of pain in healthy individuals, the extent to which the analgesic effect of acute exercise may generalize to patients with chronic pain conditions such as knee OA remains unknown. In a recent trial examining the role of physical activity in the treatment of knee OA, pain intensity was found to be inversely related to time spent engaging in aerobic exercise. This finding led the authors to suggest that acute exercise may exacerbate pain symptoms among patients with knee OA and this acute pain may act to compromise compliance with chronic exercise training (11). Nevertheless, there is a lack of empirical evidence of the pain responses to acute physical activity.
Diurnal Variations in Pain Perception

There is no question that pain perception is caused by the joint influence of psychological and physiological input (23,24). Because many of the variables that influence pain perception demonstrate diurnal variations, it has been proposed that pain levels may vary as a function of time of day. However, empirical support for diurnal variations in chronic pain remains equivocal; different diseases demonstrate divergent diurnal rhythms. For example, pain intensity from myocardial infarction (25) and dental caries (26) peaks in the early morning hours, whereas intractable pain has been found to increase throughout the day (27). Within the context of arthritic pain, peak pain intensity has been observed to occur in the morning in rheumatoid arthritis (RA) patients (12-13,28) and toward the end of the day in OA patients (29,30). Furthermore, among OA patients, considerable interindividual differences in time of peak pain have been detected (29,30). Although such individual-specific diurnal variations in pain have important implications for the treatment of OA patients (11), their potential influence on the efficacy of exercise interventions has yet to be adequately defined.

This Study

Although knee pain intensity has been found to predict time spent exercising in older adults with knee OA (11), a comprehensive understanding of pain experienced during acute exercise or how long it persists following the cessation of activity remains elusive. Consequently, delineating the unique contributions of acute exercise and diurnal variations to daily pain levels would assist in establishing additional knowledge of the acceptability of exercise as an adjunct intervention in the management of knee OA. Nevertheless, an issue often overlooked in the study of clinical pain is the limitation inherent to commonly employed pain assessment procedures. That is, many investigations have used retrospective assessment or measurement of pain at a single point in time, usually within the context of visits to a clinic. Systematic biases may distort retrospective recall, and pain measured in a clinical setting may not be representative of pain in a patient’s naturalistic environment (11). In situ monitoring techniques such as the ecological momentary assessment (EMA) method directly address such limitations (31,32) and have been employed previously to assess fluctuations in daily pain perception within rheumatological populations. For example, using a prospective daily design, Affleck et al. (32) observed divergent relationships among mood, coping strategies in male and female patients with OA and RA. EMA procedures have also been employed to investigate the role of arthritis self-efficacy in reports of daily pain, mood, and pain coping strategies in adults (33). Additionally, the EMA method has been used to examine the influence of daily mood and stressful events on pain symptoms in children with juvenile rheumatic disease (34). In this study, the EMA method was used to examine the effect of acute exercise on pain levels in older, overweight, or obese adults with knee OA. In these analyses, we initially controlled for pain variations associated with psychosocial stress and supplemental medication use and then examined the impact of involvement in acute exercise. Because of the possibility that mood, and in particular negative affect, might be confounded with pain reports, we conducted ancillary analyses of negative affect to rule out the possibility that any pain fluctuations associated with exercise involvement could be attributed to negative affect.

METHODS

Participants

All participants in the study were recruited from the exercise-only and combination of diet and exercise arms of the Arthritis, Diet, and Activity Promotion Trial (ADAPT) being conducted at Wake Forest University. Participants in this single-blinded, 18-month randomized clinical trial were randomly assigned to one of four treatment groups: dietary weight loss, exercise training, combined exercise/dietary weight loss, or healthy lifestyle control. The primary objective of ADAPT was to examine the influence of diet, exercise, and a combination of diet and exercise on physical function in sedentary, older, overweight, or obese adults with knee OA. Thirty-two ambulatory participants (25 female and 7 male) with symptomatic knee OA volunteered to participate in this ancillary study. To increase the generalizability of our findings, we recruited 10 participants who had been in ADAPT for 0 to 2 months, 11 participants who had been in the program for 2 to 4 months, and 11 participants who had been with the program for 4 to 6 months. On entry into the ADAPT study, all participants were clinically overweight or obese (body mass index > 27.5), sedentary adults older than 60 years of age with radiographic evidence of OA in at least one knee as documented by a minimum score of II on the Kellgren–Lawrence scale (35). All participants in ADAPT also demonstrated self-reported pain, functional disability, and difficulty with activities related to knee pain. Each volunteer provided informed written consent before participation in the study.

Measures

Kellgren–Lawrence scale. X rays of the knee joint were used to verify initial disease status for inclusion in the ADAPT trial. Radiological assessment included an examination of joint space, narrowing, osteophytes, subchondral cysts, sclerosis, and chondrocalcinosis. Scoring ranged from 0 (normal knee without an indication of OA), I (mild disease), II (moderate disease) to III (severe disease) according to the presence of each of the aforementioned conditions (35).

Knee pain. The intensity of knee pain was assessed using a measure that was developed specifically for individuals with knee OA—the Knee Pain Scale (KPS) (36). This subscale of the KPS evaluates the intensity of knee pain experienced during ambulatory activities of daily living and was thus conceptually linked to the exercise intervention. The measure has three items that are rated on a six-point Likert-type scale with the following anchors at each integer: 1 (no pain), 2 (mild pain), 3 (discomforting pain), 4 (distressing pain), 5 (horrible pain), and 6 (excruciating pain). The ambulatory items include climbing up stairs, going down a flight of stairs, and walking a short distance (1 block). Means were calculated for the three items and could