ABSTRACT
The purpose of this study was to investigate muscle pain intensity rating using a 10-point category-ratio pain intensity scale during self-paced cycling exercise within three trials. Eleven subjects (age 21.4 ± 2.6 years; VO2 peak 3.3 ± 0.9 L·min⁻¹) performed a 60-min cycling trial on three occasions. During each trial subjects cycled at the utmost work intensity for 60-min. To simulate competitive training, 1-min maximal effort sprints were performed every 10-mins into the trial. Ambient temperature and relative humidity were set at 33 ± 0.7 °C and 63 ± 2.0%, respectively. During exercise, subjects ranked the muscle pain intensity at 5 min intervals and following each sprint effort. Simple main effects revealed that muscle pain intensity ratings were significantly lower in trial 3 compared with trial 1 at the 50 min [F = 4.5(2, 30); p = 0.015; eta² = 0.05], 55 min [F = 4.89(2, 30); p = 0.011; eta² = 0.05], and 60 min [F = 3.6(2, 30); p = 0.034; eta² = 0.04] time interval. Repeated measures ANOVA revealed a significant increase in the mean distance cycled amongst the trials (p < 0.001). These results indicate an attenuation in muscle pain intensity rating with endurance exercise training when performed over three trials. The reduced pain intensity rating may be due to adjustments in cadence and gear selection amongst the trials.

KEY WORDS: Pain, intensity, training, rating, cycling.
and Gisbers (1981), tolerance to ischaemic pain in competitive swimmers was found to differ with the training status of the athletes. The study noted that changes in pain tolerance during the training season indicated a short-term adaptation to pain as a result of systematic exposure to brief periods of intense exercise. In a study by Egan (1987), it was suggested that training for specific sports may desensitise athletes to pain.

Few studies have reported on the rating of muscle pain intensity during vigorous and enduring physical exercise and there is an absence of research determining muscle pain intensity rating during self-paced exercise training trials. Therefore the purpose of this study was to assess muscle pain intensity rating during the performance of self-paced cycling exercise amongst three repeated trials.

**METHODS**

**Subjects**
Eleven cyclists (eight men, three women) with a range of cycling abilities were recruited for the study. All participants were apparently healthy, having completed a health history questionnaire. The participants were physically active individuals and were familiar with cycling exercise and the performance of intense physical activity for extended periods. The study was conducted with the approval of the Charles Sturt University Ethics in Human Research Committee and all subjects signed a letter of informed consent.

Descriptive measurements and peak oxygen uptake (VO\textsubscript{2 peak}) were obtained during a familiarisation session before participating in three repeated cycling trials. For determining body fat, skinfold measurements were collected from triceps and subscapular in duplicate using skinfold callipers (British Indicators Ltd, England). The percent bodyfat was determined using the method described by McArdle et al (1991). Standing height was measured to the nearest 0.1 centimetre using a precision stadiometer (Len Blaydon, Lugarno, Australia) while body mass was measured to the nearest 10g using an electronic precision balance (HW-100KAI, GEC, Avery Ltd, Australia). The nearest 10g using an electronic precision balance.

**Exercise training protocol**
Subjects were required to complete three cycling time trials in warm humid conditions. The aim was to cycle the greatest distance possible within the allotted 60 minutes, adjusting pedalling speed and gear ratio as required. A higher temperature and humidity were established to simulate intense training conditions during cycling in a warmer climate and to determine the exercise protocol reliability, as previously published (Marino et al., 2002). The temperature and humidity was set at 33 ± 0.7°C and 63 ± 2.0%, respectively. Trials were separated by at least 5 days to avoid partial heat acclimation through the trials, and within 14 days. A fan providing a constant wind speed of 2 ms\(^{-1}\) was positioned directly in front of the subject. Subjects were allowed to drink water *ad libitum* throughout each trial.

The trial was performed by subjects using their own bicycle mounted to an electromagnetic cycle trainer. The cumulative distance cycled and the power output was recorded at 5 minute intervals. The distance travelled and power output was recorded from the digital display unit connected to the cycle trainer. The cycle trainer was calibrated for distance accuracy before each trial by recording the pedal revolutions required to cycle 5 km. This procedure yielded a coefficient of variation of 0.7%. During each trial, subjects were permitted to alter gear ratio and cadence as required. This procedure provided a self-selected exercise intensity, as is often performed during exercise training.

In order to provide an additional measure of performance and to simulate intense training conditions, subjects were also required to perform 60 seconds of maximal effort ‘sprint’ exertions
every 10 minutes into the trial. During the non-sprint phases, subjects could return to a self-selected cycling intensity. Subjects were provided with ongoing performance results including elapsed time, heart rate, and a time count leading into each sprint effort.

**Pain Intensity data collection**

During each cycling trial, a category ratio pain intensity scale with verbal anchors was displayed in front of the subject for viewing during exercise. The scale was numbered 0 - 10. The verbal anchors and numerical values for the scale are as follows; 0 no pain at all, ½ very faint pain, 1 weak pain, 2 mild pain, 3 moderate pain, 4 somewhat strong pain, 5 strong pain, 7 very strong pain, 10 extremely intense pain (almost unbearable). Subjects were instructed to view the scale and apply it to rank the intensity of pain in the thigh muscles at each moment of report during cycling exercise. The verbal ranking of the pain intensity was acquired every 5 minutes into the trial. The pain rating for the sprint phases were obtained immediately after each sprint effort. The ratings at 10, 20, 30, 40, 50, 60 min represent the pain intensity during the sprint phases of the trial. The ratings at 5, 15, 25, 35, 45, 55 min represent pain intensity for the non-sprint phases during self-paced exercise.

**Statistics**

The data for pain intensity were analysed by a 2-way repeated measures ANOVA (TIME x TRIAL). Significant interactions were analysed by simple main effects and Tukey’s HSD post-hoc procedure was used where appropriate. When appropriate, the \( \eta^2 \) was used as a measure of the magnitude of association among variables. Rough estimates for the strength of association for a given \( \eta^2 \) value are that 0.01 is considered a small effect, 0.09 medium, and 0.15 large. The data for cycling distance were analysed by 1-way repeated measures ANOVA for trial. The data for power output were measured by 2-way ANOVA (TIME x TRIAL). All data are presented as mean ± SD and the level of significance was set at \( p < 0.05 \).

**RESULTS**

**Descriptive characteristics of subjects**

The mean age of the subjects was 21.4 ± 2.6 years, height 176.3 ± 10.8 cm, weight 74.9 ± 10.0 kg, body fat % 14.2 ± 5.0, \( \text{VO}_2 \) peak 3.3 ± 0.9 L·min\(^{-1}\), peak power output 322.8 ± 86.3 watts.

**Muscle Pain Intensity ratings during three cycling trials**

The muscle pain intensity ratings during the three cycling trials are presented in figure 1. There was a significant main effect for exercise time \([F = 118(2, 30); p < 0.001; \eta^2 = 0.54]\), indicating a significant increase in muscle pain intensity rating during exercise. There was a significant exercise time by trial interaction \([F = 6.3(2, 30); p = 0.005; \eta^2 < 0.01]\). Post hoc comparisons revealed that muscle pain intensity ratings were significantly lower in the

![Figure 1. Pain intensity ratings during cycling exercise for three repeated trials. The values at the 10, 20, 30, 40, 50, 60 min intervals represent the pain intensity rating for the sprint phases. The non-sprint pain intensity ratings are 5, 15, 25, 35, 45, 55 min. * Significant differences from trial 1.](image-url)
third trial compared with trial 1 at the 50 min \( F = 4.5(2, 30); p = 0.015; \text{eta}^2 = 0.05 \), 55 min \( F = 4.89(2, 30); p = 0.011; \text{eta}^2 = 0.05 \), and 60 min \( F = 3.6(2, 30); p = 0.034; \text{eta}^2 = 0.04 \) time interval.

**Cycling performance in three cycling trials**

Repeated measures ANOVA revealed a significant increase in the mean distance cycled amongst the trials \( F = 14.163(2, 32); p < 0.001; \text{eta}^2 = 0.01 \). The mean distance cycled for trials 1, 2 and 3 were 26.3 \( \pm 5.0 \), 27.7 \( \pm 5.7 \) and 28.1 \( \pm 5.6 \) km, respectively. The distance cycled in trial 1 was significantly different from trial 2 \( p < 0.01 \) and 3 \( p < 0.001 \). The mean power output for trial 1, 2 and 3 were 229 \( \pm 48 \), 241 \( \pm 74 \), 224 \( \pm 53 \) W, respectively. There was no main effect for power output by exercise time \( F = 1.9; p = 0.176 \) or exercise time by trial interaction \( F = 1.9(2, 30); p = 0.161 \).

**DISCUSSION**

The main finding in the present study was that muscle pain intensity rating decreased over the three endurance cycling trials during exercise. The rating of muscle pain intensity was significantly attenuated in the final stages of the third trial. Vecchiet and Galletti (1979) reveal that a reduction in the intensity of the sensation or an increase in the latency to onset or, an increase in the level of the workload at which pain appears for the first time are apparent with training. Several studies on pain have assessed pain ratings in the acute post-exercise phase by assessing pressure pain threshold (Koltyln et al., 1996; Perrsson et al., 2000). Previous research reveals that pressure pain responses are also affected by exercise training (Scott and Gijbers, 1981). In a study by Waling et al. (2000), pressure pain responses were significantly reduced in groups that performed strength and endurance training over ten weeks. However, the present results indicate that there is a reduction in the rating of muscle pain during cycling exercise with repeated trials. This is in contrast to research by O'Brien and O' Connor (2000), showing a consistent muscle pain intensity rating with repeated trials. The contrast in results may be associated with differences in the exercise duration. The exercise duration in the present study was 40 min longer than the study by O'Brien and O'Connor (2000), and significant differences in pain rating in the present study were revealed in the later stages of the third trial.

Muscle pain rating during exercise has been shown to positively accelerate with the relative leg power output and oxygen consumption during ramped cycle ergometry (Cook et al., 1997). This suggests that the rating of muscle pain intensity is associated with exercise work intensity. However, the present results reveal a diminution in muscle pain rating between trials with no significant difference in leg power output. Although the power output remained consistent, there was a significant increase in cycling distance covered between trials. It would be expected that an increase in distance performance would also result in an increase in power output. The disparity in results may be associated with the measurement procedure. The present study applied a flexible work intensity protocol which permits the subject to modify gear ratio, cadence and power output during exercise, as is often performed during training. This allowed for dynamic variations in power output within each exercise trial. Moreover, the measurement of power output was recorded at the moment of report and the distance covered was a continuous cumulative measure over the time trial. The disparity between power output and cycling distance could be minimised with more frequent recording of power output during exercise. Other limitations within the present study may have also affected the results to some extent. The small sample of subjects, absence of monitoring the intake of substances such as caffeine (Motl et al., 2003) or medications, and the limited supervision of the subjects training schedule apart from the trials, could have affected the outcome. Subjects were briefly informed to maintain their regular training schedule and to abstain from caffeine and heavy exercise 24 h prior to each trial. However, the present data indicate that with endurance cycling trials there is a reduction in muscle pain intensity rating despite a significant increase in the cycling distance performance.

It is possible that the reduced pain rating in the present study may be associated with a training induced hypoalgesia. However, previous research indicates that alterations in cycling cadence (pedalling frequency) can significantly affect muscle pain intensity rating (Jameson and Ring, 2000). Local sensations such as muscle and knee pain during cycling exercise are increased at lower cadences for similar power output. This is probably associated with an increase in muscle force production required at lower cadences. The variable intensity protocol in the present study permitted subjects to alter the cadence by changing the pedalling frequency and gear ratio throughout each trial. Since our participants were not competitive cyclists and presented a significant increase in cycling distance performance over the trials. It is probable that adjustments in cadence and gear selection (anecdotal observations) improved the cycling distance performance and reduced the intensity of muscle pain amongst the trials.
CONCLUSIONS
The present study provides evidence that the rating of muscle pain intensity during exercise is attenuated with endurance cycling training. Furthermore, the attenuation in muscle pain intensity with training is apparent despite an increase in cycling distance performance. The decline in muscle pain rating and increased cycling performance maybe associated with adjustments in cadence and gear selection amongst the endurance trials.

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REFERENCES


KEY POINTS
- Muscle pain intensity rating was significantly reduced with three repeated cycling endurance trials.
- Attenuation in muscle pain intensity rating appeared at 50, 55, 60 mins into exercise within the third trial.
- The attenuation in muscle pain intensity with training is apparent despite an increase in cycling distance performance.
- The decline in muscle pain rating and increased cycling performance may be associated with adjustment in cadence and gear selection amongst the endurance trails.

AUTHORS BIOGRAPHY
Peter S. MICALOS
Employment
Lecturer, School of Human Movement, Charles Sturt University, Bathurst, Australia
Degree
MEd
Research interests
Exercise induced analgesia
Email: pmicalos@csu.edu.au

Frank E. MARINO
Degree
Associate Professor
Research interests
Physiological and neurological responses to exercise in hot and cool conditions
Email: fmarino@csu.edu.au
Derek KAY
Degree
PhD
Research interests
Physiological and neurological responses to exercise in the heat and the effects of hydration status.
Email: dkay@csu.edu.au

Peter Micalos
Charles Sturt University, School of Human Movement Studies, Bathurst NSW 2795, Australia