Effects of rest interval during high-repetition resistance training on strength, aerobic fitness, and repeated-sprint ability

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Abstract
The effect of altering the rest period on adaptations to high-repetition resistance training is not well known. Eighteen active females were matched according to leg strength and repeated-sprint ability and randomly allocated to one of two groups. One group performed resistance training with 20-s rest intervals between sets, while the other group employed 80-s rest intervals between sets. Both groups performed the same total training volume and load. Each group trained 3 days a week for 5 weeks [15- to 20-repetition maximum (RM), 2 – 5 sets]. Repeated-sprint ability (5 × 6-s maximal cycle sprints), 3-RM leg press strength, and anthropometry were determined before and after each training programme. There was a greater improvement in repeated-sprint ability after training with 20-s rest intervals (12.5%) than after training with 80-s rest intervals (5.4%) (P = 0.030). In contrast, there were greater improvements in strength after training with 80-s rest intervals (45.9%) than after training with 20-s rest intervals (19.6%) (P = 0.010). There were no changes in anthropometry for either group following training. These results suggest that when training volume and load are matched, despite a smaller increase in strength, 5 weeks of training with short rest periods results in greater improvements in repeated-sprint ability than the same training with long rest periods.

Keywords: Recovery duration, blood metabolites, team sports, high-intensity training, metabolic load

Introduction
Sprint performance is fundamental to success in several sports (Baker & Nance, 1999). To improve various dimensions of sprint performance, many athletes undertake resistance training. Such training has received support from research reporting that speed–strength training can markedly improve single-sprint performance (Delecusle, 1997; Delecusle et al., 1995). In addition, Dowson, Nevill, Lakomy, Nevill and Hazeldine (1998) have reported a relationship between strength of the leg muscle groups and sprint times, suggesting that strength is an important contributor to single-sprint performance.

While resistance training appears to be beneficial for single-sprint performance, little is known about the effects of such training on repeated-sprint performance. Repeated-sprint ability refers to the ability to reproduce maximal sprint efforts interspersed by short rest periods (Dawson, Fitzsimons, & Ward, 1993), and is believed to be an important fitness component of many team sports. It has previously been shown that repeated-sprint ability (power decrement) is related to first sprint performance (r = 0.89) (Bishop, Lawrence, & Spencer, 2003). Therefore, improvements in initial sprint performance may lead to a greater decrement in sprint performance during subsequent repeated sprints. Further research is therefore required to determine the effects of resistance training on repeated-sprint ability.

Any changes in repeated-sprint ability following resistance training are likely to depend on the manipulation of key training variables. Optimally designed resistance training programmes ensure a progressive overload of appropriate muscles or muscle groups that is normally achieved by manipulating the volume and intensity of exercise on a consistent and systematic basis (Pincivero, Lephart, & Karunakara, 1997). Although there is a wealth of information on the optimal training load and volume to be used during resistance training, there is a paucity of data on the manipulation of rest intervals between sets during such training (Pincivero et al., 1997). Robinson et al. (1995) examined the effects of rest interval manipulation (180 s, 90 s, and 30 s) on resistance-training-induced alterations to measures
of maximum strength, cycle peak power, and high-intensity exercise endurance over a 5-week period. Measures of peak power and high-intensity endurance exercise were obtained on a cycle ergometer, with participants performing 15 × 5-s sprints with 50-s rest between sprints. The results of Robinson and colleagues suggested that, with the exception of maximum strength, adaptations to short-term, high-volume resistance training might not be dependent on the length of rest intervals. However, the relative training intensity (percent of one-repetition maximum, 1-RM) was significantly greater for the long-rest (180 s) than the short-rest (30 s) interval group (60% vs. 50% 1-RM) (Robinson et al., 1995). Therefore, the effect of the rest interval per se on adaptations to resistance training was not determined.

Irrespective of the type of resistance training intervention, nervous system adaptations are the predominant mechanism in the early phases (up to 6 weeks) of training, which account for strength gains in non-resistance-trained participants (Kraemer & Hakkinen, 2002). Therefore, a short (5 weeks) resistance training programme with either short or long rest intervals and a high number of repetitions is likely to be accompanied by neural adaptations that result in strength gains (Kraemer & Hakkinen, 2002), which in turn can affect repeated-sprint ability. To date, however, no study has examined the effects of resistance training on repeated-sprint ability using short rests (24 s) between sprints. The main purpose of this study was to determine the effects of high-repetition resistance training, with varied recovery periods between sets, on strength and repeated-sprint ability.

Methods

Participants

Eighteen females, recreationally active in various team sports, volunteered to participate in the study. The participants had not undertaken any form of resistance training in the 12 months preceding the study. Although they were “untrained” in a resistance training sense, they continued to participate in their specific sports (hockey, netball, and soccer) while taking part in the study. Participation involved two pre-season team-training sessions (90 min duration) per week. The sports participated in are all winter sports for southern hemisphere countries, thus ensuring that the participants were all at a similar stage in their season while engaged in the study. All participants were notified of the research procedures, requirements, benefits, and risks before providing informed consent. The Institutional Research Ethics Committee granted approval for the study.

Experimental overview

Participants were initially required to attend three familiarization sessions. One session involved habituation to a 5 × 6-s repeated-sprint test on a cycle ergometer, whereas the other two sessions involved familiarization with the resistance training programme. Participants were then required to attend two test sessions: (1) a 5 × 6-s test of repeated-sprint ability on the cycle ergometer and (b) anthropometric measurements and dynamic 3-RM strength tests. These tests were all repeated at the end of the training period.

After completing the initial assessments, the participants were matched in pairs according to strength and repeated-sprint ability and then randomly allocated to one of the two resistance training programmes. The two groups subsequently undertook 5 weeks of non-concurrent resistance training. One group underwent 5 weeks of resistance training with a short rest interval (20 s) between sets (20-s rest group). The other group completed 5 weeks of identical resistance training but with a longer rest (80 s) between sets (80-s rest group). In addition, the 80-s rest group performed all test procedures before and after a 5-week period during which no resistance training was undertaken. This control period was completed before training. The data obtained from this period were used to test the reliability of various assessment procedures.

All test and training sessions were separated by at least 48 h. The participants were asked to maintain their normal diet and sport-specific training throughout the study. They were instructed not to consume food or beverages (other than water) in the 2 h before testing. Participants were also asked to refrain from alcohol consumption and not to perform vigorous exercise in the 24 h preceding testing. Food and exercise diaries were administered to each participant to record food and fluids consumed (and exercise patterns) 2 days before each test, and the participants were asked to replicate this during the post-intervention testing.

Anthropometric measurements

For body composition assessment, skinfold calipers (Harpenden, British Indicators, UK) were used to assess six anatomical sites: triceps, subscapular, supraspinale, abdominal, front thigh, and medial calf. For each of the six sites, three readings were taken and the median value was recorded. A constant tension metal tape (Lufkin, USA) was then used to measure waist, hip, thigh, and mid-thigh circumferences at the anatomical sites recommended by Norton et al. (1996).
3-RM leg press test

Participants tried to complete a particular load for the horizontal leg press for a maximum of three consecutive repetitions (3-RM). The load was subsequently increased in increments of 5 kg for the first two sets, and thereafter by 2.5 kg, until only three consecutive repetitions (maximum) were lifted. A minimum 90-s break was allowed after each successful load lifted. The 3-RM test was used instead of a 1-RM test because the participants had minimal resistance training experience. The seat position on the leg press was adjusted so that each participant's knee angle upon visual inspection appeared to be as close to 90° as possible. This seat position was recorded and subsequently used during both training and before and after 3-RM strength testing.

Ergometers

Air-braked cycle ergometers were used to conduct all cycle tests. These ergometers were interfaced with an IBM-compatible computer system to measure flywheel velocity for the calculation of work and power generated during each trial (Cyclemax, The University of Western Australia, Perth, WA). The ergometers require participants to pedal against air resistance caused by rectangular vanes attached perpendicular to the axis of rotation of the flywheel. The power output of the air-braked cycle ergometer is proportional to the cube of the flywheel velocity. Instantaneous power is expressed as the work done during a 0.2-s measuring epoch. Work done is then summed over the trial period to determine total work (J) and is expressed relative to time to determine power (W). An optical sensor monitored the velocity of the flywheel at a sampling rate of 128 pulses per flywheel revolution. Before testing, each ergometer was dynamically calibrated on a mechanical rig (Western Australian Institute of Sport, Perth, WA) across a range of power outputs (100 – 2000 W). The time to achieve peak power on these ergometers is approximately 2 – 4 s.

5 × 6-s cycle test (repeated-sprint ability)

The participants performed a pre-test warm-up consisting of 3 min of cycling at approximately 80 W, followed by three practice sprint starts. The practice starts required the participant to pedal close to maximum for 2 – 3 s, interspersed with 20 s of slow pedalling, after which a 3-min rest was permitted. The test consisted of 5 × 6-s maximal sprints every 30 s, on an air-braked, front-access, cycle ergometer (Model Ex-10, Repco, Australia). During the 24-s recovery between sprints, participants rested completely. Five seconds before starting each sprint, they were asked to assume the ready position and await the start signal. Strong verbal encouragement was provided during all sprints, which were performed in the standing position, with feet secured in the pedals by toe clips and heel straps. Measurements were obtained for total work and peak power for each of the sprints completed.

Calculation of repeated-sprint ability test scores

An absolute (total kJ) and relative (% decrement over the repeated efforts) repeated-sprint ability score was calculated for the 5 × 6-s test (Fitzsimons, Dawson, Ward, & Wilkinson, 1993). The method used to calculate the absolute (total work) and relative (% decrement) scores for the 5 × 6-s cycle test is illustrated in Table I. This test has previously been shown to be a valid and reliable test of repeated-sprint ability (Bishop, Spencer, Duffield, & Lawrence, 2001; Fitzsimons et al., 1993).

Capillary blood sampling and analysis

Glass capillary tubes were used to collect 100 μl of blood during the repeated-sprint ability test (D957G-70-125, Clinitubes, Radiometer Copenhagen). Capillary blood samples were taken at rest, immediately after, and 5 min after the repeated-sprint ability test. Blood pH and lactate concentration were determined using a blood-gas analyser (ABL 625, Radiometer Copenhagen, Denmark). The blood-gas analyser was regularly calibrated using precision standards and routinely assessed by external quality controls.

Resistance training programme design

Two different muscle endurance training programmes were adopted. One group completed

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<thead>
<tr>
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<th>Work done (kJ)</th>
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<td>1</td>
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Table I. Method used to calculate the absolute (total work) and relative (% decrement) scores for the repeated-sprint ability test.

Total work (kJ) = 30.9

Ideal work (kJ) = highest 6-s score × 5
= 6.7 × 5 repetitions
= 33.5

Decremental (%) = 100 – (Total/Ideal × 100)
= 100 – (30.9/33.5 × 100)
= 100 – 92.2
= 7.8%
15–20 repetitions for each exercise and set, with a 20-s rest interval between sets and exercises (20-s rest group). The very short rest interval between sets and exercises also increased the metabolic load on this group, as evidenced by the significantly higher blood lactate response during training. In contrast, the other group completed 15–20 repetitions for each exercise and set, with an 80-s rest interval between sets and exercises (80-s rest group). The metabolic load for this group was relatively low compared with that of the 20-s rest group, due to the longer rest interval (again, this was evidenced by the significantly lower blood lactate response during training). Although repetitions completed may have differed slightly between individuals within the same group, there was no difference in total training volume (repetitions) and load between the two groups, since each participant in the long-rest group had a “matched” partner in the 20-s rest group. The load, repetitions, and sets completed by each participant in the 20-s rest group were replicated by their 80-s rest counterpart in their training sessions. Therefore, the only difference between the two training programmes was the rest interval between sets and exercises. The rationale behind using the 20-s and 80-s rest intervals for the respective training groups was based on typical rest periods used for muscle endurance and hypertrophy resistance training programmes. In deciding to match the total training volume and load between the two groups, the "trade-off" was a potentially insufficient resistance training stimulus, since the participants in the 80-s rest group would have lifted heavier loads in subsequent sets than the participants in the 20-s rest group.

Resistance training intervention

For a summary of the acute training variables used in the study, refer to Table II. All training sessions were closely supervised to ensure the safety of the participants. For both groups, a multiple-set resistance training format was implemented, using a combination of free weights and machines. The first six exercises focused on improving lower-body strength, while additional upper-body and abdominal exercises were included for variety and completeness in the overall programme (Table III). Blood lactate concentration and heart rate response were also assessed for both training groups before, during (after the leg exercises), and immediately after a typical training session. These measures were recorded at exactly the same instants in the respective training programmes for both groups.

The mean group increase in training load over the 5-week training period for the lower-body exercises was \( \sim 10\% \) and for the upper-body exercises \( \sim 5\% \). For the first training session, the 15- to 20-RM load selected for the seated leg press and bench press was based on the 3-RM strength tests. For the other exercises, the two familiarization sessions were used to determine the load that could be lifted for 15–20 repetitions. Therefore, participants completed between 15 and 20 repetitions for each set and exercise during each training session.

The order of exercises in each session remained the same throughout the programme for both groups. For each exercise, all the stipulated sets were completed before moving onto the next exercise. After a 5-min cycle warm-up, six lower-body exercises were completed, followed by four upper-body exercises. For both the lower- and upper-body exercises, compound movements (closed kinetic chain) preceded simple movements (open kinetic chain) (Table III).

Statistical analysis

All values are reported as the mean \( \pm \) standard error. To compare differences between training with 20-s rest periods, training with 80-s rest periods, and the control period, a one way analysis of variance (ANOVA) was applied to the absolute and relative percentage difference scores. To compare differences in...
between the two resistance training programmes, a two-way ANOVA (2 groups × 2 times), with repeated measures for time (before and after resistance training), was applied to test for interaction and main effects for the dependent variables measured during the study. Follow-up dependent or independent t-tests (with Bonferroni adjustment) were applied when significant interaction effects were found. If no significant interaction effects were observed, but a tendency towards significance ($P \leq 0.1$) was apparent, then effect sizes were calculated. Statistical significance was set at $P < 0.05$. When calculating effect sizes, the pre-training standard deviations for the 20-s rest and 80-s rest groups were applied. If the effect size was large, but the statistical power was low, the likelihood of a type II error was noted.

**Results**

**Reliability**

There were no significant changes ($P > 0.05$) in any of the performance variables (3-RM leg press and repeated-sprint ability) over the 5-week control period for the group that trained with 80-s rest intervals, with the exception of body mass (kg), which increased significantly from before to after the 5 weeks (58.5 ± 2.5 to 59.5 ± 2.6 kg, $P = 0.030$). The standard error of measurement (typical error) expressed as a coefficient of variation was calculated to assess the reliability of the repeated-sprint ability test scores (average peak power and total work done) and leg press strength scores. The coefficient of variation for average peak power and total work completed during the repeated-sprint ability test was 3.9% and 3.7% respectively, while for 3-RM leg press it was 6.2%.

**Training results**

**Total body mass and anthropometry**

Body mass did not change significantly following training for either group (20-s rest group: 60.9 ± 2.3 to 61.8 ± 2.3 kg, $P = 0.694$; 80-s rest group: 59.5 ± 2.6 to 60.2 ± 2.4 kg, $P = 0.651$). For both groups, there were no significant differences from pre- to post-training for sum of six skinfolds (20-s rest group: 127 ± 9 to 123 ± 9 mm, $P = 0.193$; 80-s rest group: 107 ± 12 to 104 ± 10 mm, $P = 0.179$), thigh circumference (20-s rest group: 56.8 ± 1.2 to 58.1 ± 1.2 cm, $P = 0.853$; 80-s rest group: 55.8 ± 1.4 to 56.3 ± 1.3 cm, $P = 0.497$), or mid-thigh circumference (20-s rest group: 49.9 ± 1.2 to 52.1 ± 0.8 cm, $P = 0.617$; 80-s rest group: 50.3 ± 1.3 to 50.9 ± 1.4 cm, $P = 0.356$).

**Three-repetition maximum leg press**

The group that trained with 80-rest intervals experienced a significantly ($P = 0.030$) greater improvement in 3-RM leg press strength after training (45.9%, 98.8 ± 10.6 to 144.1 ± 9.7 kg) than the group that trained with 20-s rest intervals (19.6%, 92.7 ± 10.4 to 110.9 ± 9.7 kg). There was a significant increase in 3-RM leg press strength from pre- to post-training for the 80-s rest group only ($P = 0.001$). Although not significant ($P = 0.060$), the tendency for an increase in 3-RM leg press strength from pre- to post-training for the 20-s rest group was moderate (effect size = 0.60). Both groups experienced a significantly greater increase in leg strength compared with the change recorded for the control period ($P = 0.010$).

**Repeated-sprint ability**

After training, there was a significant increase in absolute total work completed for both groups (20-s rest group: 12.5%, 17.33 ± 2.23 kJ to 19.49 ± 1.48 kJ, $P = 0.001$; 80-s rest group: 5.4%, 17.56 ± 2.46 kJ to 18.51 ± 2.57 kJ, $P = 0.001$) (Figure 1A). The 5.4% increase for the 80-s rest group was not significantly greater than the change recorded for the control period (3.3%, $P = 0.340$). In contrast, the 20-s rest group had a significantly greater improvement in total work compared with both the 80-s rest group ($P = 0.010$) and the control period ($P = 0.001$).

For each individual sprint, there were no significant differences between groups pre-training. Absolute total work completed (individual sprints) during the repeated-sprint ability test improved significantly from re- to post- training for both groups for sprint 3 only (20-s and 80-s rest group = 11.1% and 3.9% respectively; $P = 0.020$). Although not significant, there was a tendency for an increase from pre- to post-training in both groups for sprint 2 (20-s and 80-s rest group = 12.8% and 7.7% respectively; effect size = 0.95 and 0.50 respectively) and sprint 4 (20-s and 80-s rest group = 12.4% and 5.6% respectively; effect size = 0.90 and 0.41 respectively). There was a significant increase from pre- to post-training for sprint 5 in the 20-s rest group only (14.7%; $P = 0.001$) (Figure 2). There was no significant difference for sprint 1 from pre- to post-training for either group ($P = 0.310$). Although not significant, the tendency for a difference between the two groups after training was large for sprint 2 (effect size = 0.70) and moderate for sprint 3 (effect size = 0.51).

Average peak power (all sprints) improved significantly from pre- to post-training for both groups. There was a 9.6% increase for the 20-s rest group (739 ± 27 to 810 ± 18 W, $P = 0.001$) and a 3.9% increase for the 80-s rest group (745 ± 34 to 773 ± 33 W, $P = 0.010$) (Figure 1B). However, the
3.9% increase for the 80-s rest group was not significantly greater than the change recorded during the control period \( (P = 0.800) \). The 20-s rest group had a significantly greater improvement in average peak power compared with both the 80-s rest group \( (P = 0.020) \) and the control period \( (P = 0.020) \).

**Blood metabolites**

Following training, there was a moderate tendency towards an increase in blood lactate concentration after the repeated-sprint ability test for the 80-s rest group \( (9.9 \pm 0.8 \text{ to } 10.9 \pm 0.7 \text{ mmol} \cdot 1^{-1}) \),
Resistance training and repeated-sprint ability

Resistance training improved both leg strength and ability. Our main finding was that 5 weeks of resistance training improved both leg strength and repeated-sprint ability for both the 20-s rest and 80-s rest groups compared with the change recorded during a control period. There was, however, a greater improvement in leg strength post-training for the 80-s rest than the 20-s rest group. In contrast, there was a greater improvement in repeated-sprint ability post-training for the 20-s rest than the 80-rest group. No significant changes in anthropometry were evident following training in either group. These results suggest that in recreationally active female team-sport athletes, with no resistance training history, improvements in repeated-sprint ability after high-repetition resistance training are possible without large increases in strength.

Blood lactate response during resistance training

During a typical resistance training session, there was a significantly lower blood lactate concentration immediately after leg exercises for 80-s rest group (4.7 ± 0.4 mmol·l⁻¹) compared with the 20-s rest group (8.8 ± 0.7 mmol·l⁻¹; P = 0.001). Immediately after the training session, there was also a significant difference in blood lactate concentration for the 80-s rest group (6.8 ± 0.6 mmol·l⁻¹) compared with the 20-s rest group (11.4 ± 0.6 mmol·l⁻¹; P = 0.001).

Mean heart rate response during resistance training

There was a significant difference in the heart rate response immediately after leg exercises for the 80-s rest group (66 ± 3% of maximal heart rate) compared with the 20-s rest group (85 ± 2% of maximal heart rate; P = 0.001). There was also a significant difference in the heart rate response immediately after the resistance training session for the 80-s rest group (65 ± 4% of maximal heart rate) compared with the 20-s rest group (84 ± 2% of maximal heart rate; P = 0.001).

Discussion

The purpose of this study was to investigate the effects of high-repetition resistance training, and the effects of recovery duration between sets (with total training load and volume matched), on repeated-sprint ability. We matched the training load and volume between the two resistance training groups, and thus the training programme for the 80-s rest group might not have been optimal. However, it did invoke a sufficient training stimulus to elicit a large increase in leg strength (~46%). We chose to match the training load and volume between the groups so as to determine the effect of the rest interval between sets per se on strength and repeated-sprint ability. Our main finding was that 5 weeks of resistance training improved both leg strength and
training load and volume used in the short between-sets rest interval (40 s) was the same as that used for the long between-sets rest interval (160 s). Robinson et al. (1995) also suggested that maximum strength adaptations to short-term, high-volume training are dependent on the length of between-sets rest intervals. While neither of the studies suggested a possible mechanism, a recent study involving rats has reported that acute metabolic acidosis can inhibit protein synthesis (Caso, Garlick, Casella, Sasvary, & Garlick, 2004). Therefore, while more research is needed, it is possible that greater H⁺ accumulation, as a result of shorter rest intervals, may impede neurological adaptations and the upregulation of myosin heavy chain expression associated with resistance training (Staron et al., 1994). Although not measured directly in the present study, the greater blood lactate concentration recorded during the short-rest than long-rest training programme indicates that greater H⁺ accumulation was likely in the 20-s rest group than in the 80-s rest group.

Another potential contributing factor to compromised strength gains in the 20-s rest group relates to cumulative neural fatigue over the duration of the resistance training programme. During resistance training, the more rest between sets and exercises, the more optimal the motor unit recruitment (Kraemer & Hakkinen, 2002). Part of the training adaptation (in untrained individuals) is developing the ability to recruit the maximum number of motor units at a high enough frequency to produce force to overcome a load, when completing a task (Kraemer, 1997). The repeated bouts of short rest intervals between sets for the 20-s rest group may have resulted in incomplete neurological recovery. This in turn could impede or interfere with various neurological adaptations that would occur over the course of the training. Thus, sub-optimal motor unit recruitment is a potential mechanism leading to compromised strength gains when resistance training is performed with short rest intervals (Aagaard, Simonsen, Andersen, Magnusson, & Dyhre-Poulsen, 2002; Staron et al., 1994).

**Repeated-sprint ability**

Total work and average peak power (all sprints) completed during the repeated-sprint ability test increased for both groups following resistance training (20-s and 80-s rest groups = 10 – 13% and 4 – 5% respectively), and was significantly greater in the 20-s rest group after training. Therefore, our results show that when the training load and volume of each set is equal, shorter rest periods between sets result in greater improvements in repeated-sprint ability in non-resistance-trained, recreationally active team-sport females. In contrast, Robinson et al. (1995) reported that high-intensity exercise endurance (15 × 5-s sprints, separated by 50-s rest intervals) did not differ significantly between three groups who performed resistance training using 180-s, 90-s, and 30-s rest intervals respectively. However, in their study there was a significant difference in average training volume (repetitions × load lifted) over the 5 weeks between the 180-s and 30-s groups (3774 vs. 3078 kg). Thus, any potentially greater adaptations in the 30-s group might have been negated by a significantly lower training volume. It is also possible that differences between the two studies are related to the test protocol used, since their high-intensity exercise protocol involved 15 × 5-s sprints, separated by 50-s rest intervals, whereas the present study used 5 × 6-s repeated sprints separated by 24-s rest intervals.

Improvements in repeated-sprint ability in the present study for both groups are likely to be accounted for, in part, by strength gains (Aagaard et al., 2002; Fleck & Kraemer, 1997). However, despite half the increase in leg strength, improvements in repeated-sprint ability were greater in the 20-s rest group than 80-s rest group. This interesting finding suggests that improvements in repeated-sprint ability are not linearly related to increases in strength. Furthermore, in addition to strength gains, it is likely that other mechanisms contributed to improvements in repeated-sprint ability, especially for the 20-s rest group. In support of this, a recent study reported no correlation between isokinetic leg strength and repeated-sprint ability (Newman, Tarpenning, & Marino, 2004). Therefore, the present study shows that high-repetition resistance training can improve repeated-sprint ability in non-resistance-trained, recreationally active team-sport players, and that this improvement is greater when there is a shorter rest interval between sets, with training load and volume matched.

Following training, there was a tendency ($P = 0.08$, effect size = 0.64) towards a reduction (12%) in blood lactate concentration after the repeated-sprint ability test for the 20-s rest group. In contrast, there was a tendency ($P = 0.08$, effect size = 0.42) towards an increase (10%) in blood lactate concentration after the repeated-sprint ability test for the 80-s rest group. The relative percentage change in blood lactate concentration from pre- to post-training was significantly different between the two groups (20-s rest and 80-s rest group = –12.2% and +10.0% respectively; $P = 0.019$). Harber et al. (2004) reported a significantly attenuated exercise-induced blood lactate response to a standard 10-week circuit weight training programme in untrained males (training 3 times a week, 10 exercises, 30-s lifting time, 30-s rest interval, 1 – 3 sets). Thus, the
results of the present study are in line with those of previous research suggesting that resistance training with short rest intervals results in a reduction in post-exercise blood lactate concentration after repeated sprints.

As the key performance variable (repeated-sprint ability) was maximal, it is unlikely that after the resistance training there was an increased aerobic energy contribution and decreased anaerobic energy contribution to the sprints (resulting in less lactate production). This is especially unlikely as post-training there was a significant increase in absolute total work completed during the repeated-sprint ability test. Therefore, although not significant, the reduced blood lactate response after the repeated-sprint ability test for the 20-s rest group could have been due to greater lactate clearance (Donovan & Brooks, 1983). High-intensity (leg extension) resistance training has previously been shown to increase the concentration of lactate transporters (MCT1 and MCT4), resulting in increased lactate clearance (Bonen, 2001; Juel, Holten, & Dela, 2004; Pilegaard et al., 1999). While further research is required to identify the mechanisms underlying the tendency towards a reduced blood lactate response after the repeated-sprint ability test, the present research suggests that high-repetition resistance training incorporating short, not long, rest intervals may reduce the blood lactate response associated with a maximal bout of exercise.

In summary, although both forms of high-repetition resistance training improved repeated-sprint ability, the 20-s rest interval training had a more beneficial effect on this performance despite a significantly smaller increase in leg strength. However, the findings should be interpreted with caution, since they represent recreationally active female team-sport athletes, with no resistance training history. Furthermore, although the sensitivity and specificity of the test measures used reduces the ecological validity of the study, it does allow some comparisons to be made with other studies, and represents a valid attempt to assess the effectiveness of using a resistance training modality (as opposed to cycle- or running-based interval training) to improve repeated-sprint ability in the aforementioned population. Therefore, further research is required to: (a) investigate the effects of using a similar resistance training programme in either males or females with a background of resistance training, and then assessing this using more specific running-based tests of repeated-sprint ability, and (b) examine the mechanisms by which short rest intervals (20 s) compromise strength gains, but result in greater improvements in repeated-sprint ability, compared with longer rest intervals (80 s).

References


