http://dx.doi.org/10.1519/JSC.0b013e3182429b0b

Lockie, R.G., Murphy, A.J., Scott, B.R., and Janse de Jonge, X.A.K. (2012) *Quantifying Session Ratings of Perceived Exertion for Field-Based Speed Training Methods in Team Sport Athletes*. Journal of Strength and Conditioning Research, 26 (10). pp. 2721-2728.

Quantifying Session Ratings of Perceived Exertion for Field-Based Speed Training Methods in Team Sport Athletes

Abstract

Session ratings of perceived exertion (session-RPE) are commonly used to assess global training intensity for team sports. However, there is little research quantifying the intensity of field-based training protocols for speed development. The study aim was to determine the session-RPE of popular training protocols (free sprint [FST], resisted sprint [RST], plyometrics [PT]) designed to improve sprint acceleration over 10 meters (m) in team sport athletes. Twenty-seven men (age = 23.3 ± 4.7 years; mass = 84.5 ± 8.9 kilograms; height = 1.83 ± 0.07 m) were divided into three groups according to 10-m velocity. Training consisted of an incremental program featuring two one-hour sessions per week for six weeks. Subjects recorded session-RPE 30 minutes post-training using the Borg Category Ratio-10 scale. Repeated measures analysis of variance found significant ($p < 0.05$) changes in sprint velocity and session-RPE over the six weeks. All groups significantly increased 0-5 and 0-10 m velocity by 4-7%, with no differences between groups. There were no significant differences in session-RPE between the groups, suggesting protocols were matched for intensity. Session-RPE significantly increased over the 6 weeks for all groups, ranging from 3.75-5.50. This equated to intensities of Somewhat Hard to Hard. Post-hoc testing revealed few significant weekly increases, suggesting that session-RPE may not be sensitive to weekly load increases in sprint and plyometrics training programs. Another explanation, however, could be that the weekly load increments used were not great enough to increase perceived exertion. Nonetheless, the progressive overload of each program was sufficient to improve 10-m sprint performance. The session-RPE values from the current study could be used to assess workload for speed training periodization within a team sport's conditioning program.

Key Words: session-RPE, training load, sprint training, resisted sprinting, plyometrics

INTRODUCTION

The demands of team sports (e.g. the different football codes, basketball, European handball) require athletes to train with a diverse range of activities. This can include exercises that focus on training the aerobic and anaerobic systems exclusively, skill-based activities that develop motor abilities, and strength, power and speed-based activities (29, 30). Speed and acceleration are a valuable component of a field sport athlete's skill set. Sprint efforts during team sports are often centred around important, match-defining moments (32). As evidenced by a survey of the strength and conditioning coaches of America's National Football League (9), there is a wide range of training techniques used to develop speed in field sports. Some of the training protocols that can improve speed in team sport athletes include free sprinting (22, 36), resisted sprinting (14, 36), and plyometrics (33).

In order to balance the varied requirements of team sports over the course of a season, a periodized training plan must be developed. The intensity of each of the different training methods used by the coaching staff must be considered to assist with this process (19). When considering training sessions that are aerobic in nature, heart rate is often used in the assessment of training intensity. However, the validity of heart rate analysis has been questioned when assessing very high-intensity or short duration activities such as plyometrics training, or sprint training for maximal speed (16). The slow heart rate response to short duration high-intensity bouts of activity is an acknowledged limitation of heart rate measurement (1). As a result, using heart rate to measure the intensity of sprint or plyometrics training may not provide an accurate indication of the physical exertion experienced by the athlete.

Perceived exertion has been defined as a sense of effort experienced while performing physical or mental work (15). Session ratings of perceived exertion (session-RPE), in which a nominal score is given by an athlete to describe their perceived effort during a training session, has become a useful method by which exercise intensity can be monitored. Session-RPE has been found to correlate with heart rate response during aerobic activities and to be a reliable indicator of training intensity in intermittent sport-specific settings, such as soccer (2, 16, 24). However, session-RPE can encompass more than just the physiological response (e.g. heart rate) to exercise. Factors such as an individual's psychological awareness (31), external environment (5), training status and experience (40), and the external workload experienced (17), can affect the internal load of an exercise, and thus be reflected in session-RPE. This is especially important when considering high-intensity, short-duration activities, which may not elicit significant changes in heart rate. Previous research has supported the use of session-RPE in assessing resistance training intensity (7, 13, 23), and has found it comparable to session-RPE assessment of aerobic activities (39). Similar to resistance training, activities targeting speed development may not elicit a heart rate response that effectively captures the intensity of the effort. Thus, session-RPE may be a useful method to monitor the intensity of these types of activities.

While session-RPE has been used to monitor team sport field training (2, 16, 24), there has been minimal research that has isolated field-based speed training protocols in order to monitor perceived exertion. As speed is a vital requirement for team sport athletes, determining the intensity that can be associated with field-based sprint and power training is important to allow for appropriate periodization within an athlete's season plan. Therefore, the aim of this study is to quantify the session-RPE of field-based speed training programs involving free sprinting, resisted sprinting, and plyometrics. These programs will be periodized incrementally such that the intensity of each protocol will increase each week, and the sensitivity of session-RPE to these changes will be determined. The Borg Category Ratio-10 (CR-10) scale (Table 1) will be used for the assessment of perceived exertion. It is hypothesized that session-RPE will increase weekly, in congruence with the incremental design of each program, across all training protocols. Due to the inherent design of each program, it is also hypothesized that the initial training sessions for all protocols should fall within a session-RPE range of 3-4 (Moderate to Somewhat Hard). As the programs progress over the training period, session-RPE should increase and fall within a range of 5-6 (Hard to Very Hard). The results of this study will provide valuable information for strength and conditioning practitioners who need to monitor the intensity of team sport athletes conditioning programs, by providing a nominal value of intensity for three popular field-based speed training protocols.

INSERT TABLE 1 NEAR HERE

METHODS

Experimental Approach to the Problem

This investigation aimed to quantify the intensity of three training protocols targeting the development of sprint acceleration in team sport athletes – free sprinting, resisted sprinting, and plyometrics. The subjects were required to perform 10-meter (m) sprint tests before and after a six-week incremental training program involving one of the three protocols. Throughout the training program, subjects reported session-RPE to one of the investigators 30 minutes after the conclusion of each session. This provided information about how subjects perceived the intensity of the free sprint, resisted sprint, and plyometrics training. In addition to the quantification of session-RPE, this study will also define whether session-RPE is sensitive to weekly changes in workload from incremental, speed-based training protocols. The independent variables were the three training protocols (i.e. free sprint, resisted sprint, and plyometrics training). Dependent variables included sprint velocity over the selected intervals of 0-5 m, 5-10 m, and 0-10 m; and the session-RPE recorded for each training session. Session-RPE was averaged over the two weekly sessions to provide a mean value for the week for each subject.

Subjects

Twenty-seven healthy men (age = 23.3 ± 4.7 years; mass = 84.5 ± 8.9 kilograms; height = 1.83 ± 0.07 m) volunteered to participate in this study. Subjects were recruited if they (a) were currently active in a team sport (i.e. rugby union, rugby league, Australian Rules football, soccer, basketball), (b) had a general team sport training history (≥2 times·week^{-1}) extending over the previous twelve months, (c) did not have any existing medical conditions that would compromise participation in the study, and (d) agreed to follow a predetermined training program (36). The study occurred during the winter competition season of the major sporting codes (14, 27, 36). As the subjects were amateur athletes from a variety of local teams, the researchers could not control the extra team sport training completed by the subjects. Nonetheless, to exercise a degree of control, for the duration of the study subjects were instructed to continue with their normal physical activity. This generally consisted of two field- or court-based and two gym-based training sessions per week, and one game per week (27, 36). The methodology and procedures used in this study were approved by the institutional ethics committee. All subjects received a clear explanation of the study, including the risks and benefits of participation, and written informed consent was provided prior to testing.

Sample size was determined by estimating the magnitude of differences between the effect sizes that would theoretically result from the training protocols. As effect size may be measured in relation to the principle assessment criterion, 0-10 m velocity was used. Based on research examining sprint acceleration training (36), it was assumed that the effect size for the present study would be large (0.8). An 80% confidence level was desired, and power was set at 0.8. Consequently, with an expected effect size of 0.8 and alpha level of 0.05, the sample size used in the study was considered adequate to determine changes in the dependent variables with sufficient statistical power (20).

Procedures

Subject's RPE responses were collected throughout the training period and speed was assessed prior to and following the six weeks of training. Testing of speed was conducted during one session, which involved four 10-m sprints which were timed for kinematic analysis. Prior to data collection, the subject's age, height, and mass were recorded. A standardized warm-up, consisting of ten minutes of jogging, ten minutes of dynamic stretching of the lower limbs, and progressive speed runs over the sprint testing distance (two repetitions each at 60%, 70%, 80%, and 90% of perceived maximum velocity), was used. Post-testing was conducted within a week of the subject's final training session. For the duration of the study, subjects refrained from intensive exercise in the 24 hours prior to each testing occasion. They were not to eat for 3-4 hours prior to any testing session, and were instructed to follow the same diet on the day of each trial. Subjects also abstained from caffeine, alcohol, and nicotine in the 24-hour period before testing. This is in accordance with previous research that has analyzed session-RPE (10, 13).

Speed Assessment

As stated, subjects completed four 10-m sprints which were used to assess changes in speed performance. This 10-m distance is indicative of the initial acceleration phase important to field sport athletes (8, 26, 35). Recovery periods of two minutes were allocated between sprint trials. Sprint time was measured through the use of a velocimeter (Onspot©, Wollongong, Australia). The velocimeter consisted of a stopwatch (Seiko©, Tokyo, Japan) and a nylon line attached to a reel, which allowed the line to unwind unimpeded when the subject began their sprint. An optical sensor sent electrical impulses to the velocimeter's processor for every 0.1-m of linear line displacement. The velocimeter was placed upon a 0.72 m-high table, 1.5 m behind the subject for each trial. The line was attached to the back of the subject's shorts. The stopwatch was activated with the first movement of the subject. Subjects were instructed not to hesitate at the start of their sprint, as this would falsely trigger the velocimeter. If a subject did move and trigger the timer, the trial was disregarded and another attempt was allowed after the requisite recovery period. The recorded times for the three chosen intervals (0-5 m, 5-10 m, and 0-10 m) were then calculated through the equation $velocity = displacement \cdot time^{-1}$. The reliability of the data collection procedures for the timing of sprint performance used in this study has been previously established (26).

Training Groups

After baseline pre-testing, subjects were ranked according to their 0-10 m velocity and randomly allocated into the three training groups. These groups were (1) free sprint training (FST; n = 9), (2) resisted sprint training (RST; n = 9), and (3) plyometrics training (PT; n = 9). These protocols were chosen as they are commonly used in the training of team sport athletes (9, 14, 22, 33, 36), but have not been individually monitored by session-RPE in the current literature. A six-week training program was used, as previous research has shown that this time period is sufficient to induce changes in speed and power (22, 37). Subjects refrained from intensive training in the twenty-four hours prior to each session. During the six-week training period, all participants were required to complete their assigned training sessions on two non-consecutive days per week. All training sessions were conducted in the early evening after 5pm at the university and supervised by the researchers.

All training programs followed a periodized plan to ensure a progressive overload was achieved (Table 2). Each session for all protocols lasted for approximately sixty minutes. The sprint training programs (free and resisted) progressively increased the total distance run each week (36). The RST group towed a load that induced a 10% reduction in velocity (14, 36), which was determined through previously established methods (25). The FST and RST groups were matched as both used the same sprint program. The plyometrics program included exercises involving bilateral (box jump, double leg hurdle jump, drop jump), and unilateral (alternate leg bound, single leg forward hop) exercises, and increased the total number of ground contacts per week (37). Either the distance covered or number of ground contacts for both the sprint and plyometrics training programs increased by an average of approximately 11% per week. Two minutes of rest was allowed between each set for all programs over the six weeks.

INSERT TABLE 2 NEAR HERE

Session-RPE Assessment

In accordance with established methods (10, 12, 16), session-RPE was recorded 30 minutes after training session completion, in order to limit any bias resulting from the final exercise within a session. As previously stated, the Borg CR-10 scale was used for the assessment of perceived exertion (Table 1). This 10-point scale is an adaptation from the original scale proposed by Borg (4), and has been recommended for resistance training (28). As sprint and plyometrics training involves a structure of sets and repetitions with recovery periods similar to strength training, the Borg CR-10 scale was deemed appropriate for this study.

Each subject was given instructions on how to use the scale. A rating of 0 was associated with no effort (i.e. rest), while a rating of 10 was a maximal effort associated with the most strenuous exercise ever performed (10). Thirty minutes after the completion of a training session, subjects were to assess their session-RPE by answering the question "How was your training session?" (10). A session-RPE score was recorded for each training session during the week, and the two scores provided a weekly average which was used for analysis.

Statistical Analyses

Prior to training, descriptive statistics (mean ± standard deviation) were calculated for all subjects. Subjects were then ranked according to their 0-10 m velocity, and distributed evenly into training groups. A power level of 0.8, and a significance level of $p < 0.05$, was established for the study. In regards to sprint velocity, data were analysed via a 2-way analysis of variance (ANOVA). The training group was set as a between-subjects factor measured at 3 levels (FST, RST and PT) (3, 36). The within-subjects factor (i.e. time of test) represented the pre-training and post-training measures. As only 2 repeated measures were employed, the assumption of sphericity, determined by Mauchly's test of sphericity, was not applicable. All other repeated measures ANOVA assumptions were considered, with the Levene statistic used to determine homogeneity of variance. A repeated measures ANOVA was used to determine significant changes within and between groups for mean weekly session-RPE, considering six time points (i.e. weeks 1-6) over the training period. Mauchly's test of sphericity was checked for significance. If this test was not significant, sphericity of the data was assumed when considering the overall within-subjects effects. Effect sizes (ES) were calculated between pre- and post-test sprint velocity over each considered interval (0-5 m, 5-10 m, and 0-10 m), and between weeks for the mean session-RPE. ES was derived from the difference between the means divided by the pooled standard deviations. 0.5 and below was considered a low ES; 0.51-0.8 considered a medium ES; and 0.81 and above a large ES

(6). All statistical analyses were computed using the Statistics Package for Social Sciences (Version 18.0).

RESULTS

Velocity

The sprint velocity results are shown in Table 3. As there were no significant differences in pre-test 0-10 m velocity between the training groups, it was assumed that any changes in sprint velocity over the six-week period could be confidently related to the applied training condition. 0-5 m and 0-10 m velocity significantly ($p < 0.05$) increased for all groups after the training period. The FST group increased 0-5 m velocity by approximately 7%, the RST group by 7% and the PT group by 6%. The FST group increased 0-10 m velocity by approximately 5%, the RST group by 6% and the PT group by 4%. For each of the increases in 0-5 m and 0-10 m velocity for all groups, the ES were large, indicating the strength of the change. The PT group also significantly ($p < 0.05$; ES = 0.42) increased 5-10 m velocity by 2%. There were no significant differences in post-test velocity between the groups.

INSERT TABLE 3 NEAR HERE

Session-RPE

Figure 1 tracks the change in session-RPE week-to-week across the training period for each training protocol. The overall within-subject effect for the changes in session-RPE was significant ($p = 0.000$), indicating a general change in mean session-RPE over the training period. Mean weekly session-RPE for each training group is shown in Table 4. Using the Borg CR-10 scale as a reference (Table 1), the mean weekly session-RPE scores for the FST group increased from 4-5 (Somewhat Hard to Hard); for the RST group, mean session-RPE scores increased from 3-4 (Moderate to Somewhat Hard); and for the PT group, the increase was from 3-5 (Moderate to Hard). There were no significant differences in mean weekly session-RPE between the protocols for any of the weeks.

INSERT FIGURE 1 NEAR HERE

INSERT TABLE 4 NEAR HERE

Post hoc testing demonstrated that mean session-RPE for Weeks 4 and 6 for the FST group, was significantly ($p < 0.05$) higher than for Week 2 (Table 4). Although there was an overall rise in session-RPE over the six weeks for each group, post-hoc testing did not reveal any other significant differences between weeks for any of the protocols. Table 5 illustrates the ES for differences in session-RPE week-to-week for all training protocols. There was a medium effect for the increases in mean session-RPE from Week 3 to 4 in the FST group. The week to week ES for the other protocols and weeks were low.

INSERT TABLE 5 NEAR HERE

To further chart any progression in intensity over the training period for the groups, ES were calculated between the mean weekly session-RPE from the first (Week 1) and last (Week 6) weeks of the training cycle. The increase from Week 1 to Week 6 in mean session-RPE for the FST and PT groups had large effects, with a rise of 28% and 39%, respectively. The RST group showed a 14% increase in mean session-RPE from week 1 to 6, which registered a low ES.

DISCUSSION

Session-RPE has been regularly adopted in analyzing team sport athlete training (2, 16, 17). However, this is typically done to gauge the intensity of either aerobic-based or repeat-sprint activities. This is one of the first studies to analyze the perceived intensity of field-based training methods (i.e. free sprint, resisted sprint, and plyometrics training) designed to improve maximum speed. It is important for strength and conditioning practitioners to understand the workload associated with training protocols designed to improve sprint acceleration in the team sport environment, and the results from this study will assist that process.

The training intensity of each protocol was sufficient to induce improved sprint acceleration performance, as each training group significantly improved velocity over the 0-5 m and 0-10 m intervals (Table 3). The PT group also significantly increased 5-10 m velocity. There were no significant differences in the change in velocity between the groups. Beyond considering anything else, it is important to make sure that a training program is effective. Within the current study, the free sprint, resisted sprint, and plyometrics programs all elicited the desired training response – improved sprint acceleration over 10 m.

Session-RPE significantly increased over the six-week training program for each group, with an overall within-subject effect of $p = 0.000$ (Figure 1). This finding demonstrates the usefulness of the session-RPE method in assessing the incremental nature of the six-week training program. Post hoc testing, however, revealed few significant increases between consecutive weeks (Table 4). A potential reason for this that week-to-week session-RPE may not be sensitive enough to the incremental changes inherent with periodized field-based sprint or plyometrics training programs. With regards to resistance training, research has found that a greater training volume does not necessarily relate to increases in perceived exertion in recreationally-trained adult males (21). This could also be related to the nature of strength- and power-based exercises, which feature longer recovery periods to allow for energy-restoration between sets. Indeed, Kraemer et al. (21) suggested factors such as absolute load and rest periods between sets were more important factors.

Another possible explanation is that the increments within the training program were not large enough to result in a significant change in session-RPE from week to week. When considering the results of the current study, even though a greater load (measured through either distance run or number of jump contacts) was performed each week as the program progressed (Table 2), the subjects did not necessarily perceive this as significantly harder from week to week. It should be noted, however, that the session-RPE in Week 6 was higher than Week 1 for each training group (Tables 4 and 5, Figure 1), with an overall significant effect. This illustrates that progressive overload was achieved within each training program. Furthermore, as each group significantly improved short sprint velocity (Table 3), it can be stated that the progressive overload within each program was appropriate.

There were no significant differences in any mean weekly session-RPE between the FST, RST, and PT groups (Table 4). Given that a higher session-RPE for resistance-based exercises indicates a greater perceived intensity of effort (7, 10), it can be stated that within the context of the current study, each protocol was well matched for perceived intensity. Using the Borg CR-10 Scale (Table 2), the session-RPE values for the FST, RST, and PT groups (Table 4), were slightly lower than the training intensities hypothesized for the current study (4-7). The session-RPE recorded for the speed training protocols are also much lower than those recorded for resistance training (7, 13, 23, 38), which would have similar recovery periods to those used in the current study. Power-based training has been found to elicit lower ratings of perceived exertion when compared to strength training (10, 34). The nature of strength training, which involves lifting heavy loads at or near maximum strength levels, lends itself to increased perception of effort. Higher load (i.e. strength) training will generally be perceived as being more difficult and requiring more effort when compared to lower load (e.g. sprint) training (34). The reasoning behind this relates to time under tension and motor unit recruitment. When greater muscle tension is required, more motor units must be stimulated. This is accomplished by stronger signals being sent from the motor cortex to the sensory cortex, which will cause an increase in the perception of effort (10, 13, 34).

The session-RPE values from the protocols in the current study were similar to those found in college-aged females who completed a 6 x 6 jump squat-protocol with a load of 30% of one-repetition maximum (10). Both the current study, and Egan et al. (10), used a between-set recovery period of two minutes for training. Therefore, the relatively long recovery periods present in the free sprint, resisted sprint, and plyometrics programs, in conjunction with short activity durations, would contribute to lower session-RPE as the effects of fatigue contributing to perceived exertion are decreased. Additionally, free sprint, resisted sprint and especially plyometrics exercises all greatly utilize the stretch-shortening capacities of the lower limbs. Greater contributions from elastic energy to movement will also lessen the development of fatigue, and reduce the perception of exertion in an individual (10). It could also be inferred that if fatigue is low during the field-based speed training sessions, than this could have greater benefits when attempting to develop acceleration and maximum speed.

The results of this study also highlight, in line with Egan et al. (10), that session-RPE is dependent on the mode of training, and may not always directly relate to the relative intensity used (i.e. maximum effort sprints or jumps). This could possibly lead to the submission of a lower assessment of session-RPE by athletes for activities that place great stress on the body. This is a limitation of session-RPE when monitoring strength- and power-based activities (10). Potentially, another way to categorize the intensity of speed- and power-based training that could alleviate this issue would be to quantify the ground and joint reaction forces elicited by specific exercises (18). Indeed, plyometrics activities such as tuck and standing long jumps can elicit greater knee joint reaction forces when compared to countermovement jumps (18). This idea is worth further investigation, as impact forces could provide an accurate way to categorize the exercise intensity of power activities, especially those that feature long recovery periods that reduce the impact of fatigue on perceived exertion.

PRACTICAL APPLICATIONS

This study has shown that session-RPE can be used to assess the progressive overload of a sprint and plyometrics training cycle. The weekly increments in this study may not have been large enough to reveal weekly changes in session-RPE, but the overall cycle demonstrated a significant increase in perceived intensity. The session-RPE values from the current study could be used in the assessment of internal training load. The internal training load of a specific protocol can be calculated by multiplying the session-RPE assigned to the protocol by the duration of the activity (11). From the results established by the current study, free sprint, resisted sprint, and plyometrics programs designed to target short sprint speed could be assigned an approximate session-RPE value of 4-6. This could then be further manipulated by assigning a specific duration for each activity. The ability to define the internal load that can be associated with team sport-specific speed training will make it easier for strength and conditioning practitioners to effectively periodize the training programs for team sport athletes over the course of a season.

Although this study analyzed three protocols in isolation, these are rarely used this way in practice. Potentially, field-based speed training which combines different protocols may elicit a higher intensity as measured by session-RPE than that recorded by individual protocols in the current study. Sprint training that operates at a higher intensity, due to the combination of speed- (i.e. sprinting) and power-based (e.g. plyometrics) activities, may elicit greater increases in sprint acceleration velocity. Future research should examine how team sport athletes perceive the intensity of sprint acceleration training that involves larger weekly increments of intensity, and also combines different protocols, and whether sprint training of a higher intensity leads to greater speed improvements.

Acknowledgements

We would like to acknowledge our subjects for their contribution to the study. This research project received no external financial assistance. None of the authors have any conflict of interest.

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Figure Legend

Figure 1: Mean weekly session rating of perceived exertion (session-RPE) (mean ± standard deviation) recorded by group from six weeks of free sprint (FST), resisted sprint (RST) or plyometrics (PT) training.

* Repeated measures ANOVA demonstrated a significant (p = 0.000) within-subject effect for the increase in session-RPE over the training period for all groups.

Table 1: Session rating of perceived exertion (session-RPE) scale subjects were to refer to thirty minutes after their training session had ended (28).

Rating	Description
0	Rest
1	Very, Very Easy
2	Easy
3	Moderate
4	Somewhat Hard
5	Hard
6	-
7	Very Hard
8	-
9	-
10	Maximal

Table 2: Programs for free sprint, resisted sprint, and plyometrics training protocols (m = meters).

Week	Free Sprint and Resisted Sprint Training			Plyometrics Training		
	Interval	Sets x Reps	Distance	Exercise	Sets x Reps	Contacts
1	0-5	2 x 3	30	Box Jump	3 x 10	30
	0-10	2 x 3	60	Bounding	4 x 5	20
	0-15	1 x 3	45	Forward Hop	2 x 10	20
	0-20	1 x 3	60 (195 m)	Hurdle Jump	2 x 10	20
				Drop Jump	2 x 5	20 (100)
2	0-5	2 x 4	40	Box Jump	3 x 10	30
	0-10	2 x 4	80	Bounding	4 x 6	24
	0-15	1 x 3	45	Forward Hop	3 x 8	24
	0-20	1 x 3	60 (225 m)	Hurdle Jump	3 x 8	24
				Drop Jump	2 x 8	16 (118)
3	0-5	3 x 3	45	Box Jump	3 x 10	30
	0-10	2 x 4	80	Bounding	5 x 6	30
	0-15	1 x 4	60	Forward Hop	3 x 10	30
	0-20	1 x 3	60 (245 m)	Hurdle Jump	3 x 8	24
				Drop Jump	2 x 8	16 (130)
4	0-5	3 x 3	45	Box Jump	3 x 8	24
	0-10	3 x 3	90	Bounding	6 x 6	36
	0-15	1 x 4	60	Forward Hop	3 x 10	30
	0-20	1 x 4	80 (275 m)	Hurdle Jump	3 x 10	30
				Drop Jump	3 x 8	24 (144)
5	0-5	2 x 5	50	Box Jump	3 x 8	24
	0-10	2 x 5	100	Bounding	5 x 9	45
	0-15	1 x 4	60	Forward Hop	4 x 8	32
	0-20	1 x 4	80 (290 m)	Hurdle Jump	4 x 8	32
				Drop Jump	4 x 7	28 (161)
6	0-5	3 x 4	60	Box Jump	3 x 8	24
	0-10	3 x 4	120	Bounding	5 x 9	45
	0-15	1 x 4	60	Forward Hop	5 x 8	40
	0-20	1 x 4	80 (320 m)	Hurdle Jump	5 x 8	40
				Drop Jump	4 x 8	32 (181)

Table 3: Velocities over 0-5 meter (m), 5-10 m, and 0-10 m (mean ± standard deviation and effect size [ES]) in a 10-m sprint pre and post six weeks of free sprint (FST), resisted sprint (RST), or plyometrics (PT) training ($m \cdot s^{-1}$ = meters per second).

Velocity ($m \cdot s^{-1}$)	FST (n = 9)	RST (n = 9)	PT (n = 9)
0-5 m			
Pre	3.75 ± 0.20	3.81 ± 0.30	3.78 ± 0.18
Post	4.01 ± 0.19*	4.08 ± 0.26*	3.99 ± 0.25*
ES	1.33	0.96	0.96
5-10 m			
Pre	6.65 ± 0.34	6.49 ± 0.30	6.62 ± 0.34
Post	6.79 ± 0.27	6.50 ± 0.78	6.75 ± 0.28*
ES	0.46	0.02	0.42
0-10 m			
Pre	4.81 ± 0.28	4.79 ± 0.31	4.81 ± 0.23
Post	5.03 ± 0.21*	5.06 ± 0.29*	5.01 ± 0.24*
ES	0.89	0.90	0.85

* Significant ($p < 0.05$) difference between pre- and post-test.

Table 4: Mean session rating of perceived exertion (session-RPE) (mean ± standard deviation) recorded by group over six weeks of free sprint (FST), resisted sprint (RST) or plyometrics (PT) training.

Week	FST (n = 9)	RST (n = 9)	PT (n = 9)
1	4.07 ± 1.24	3.75 ± 1.46	3.96 ± 1.79
2	4.07 ± 1.10	4.03 ± 1.58	4.31 ± 1.58
3	4.43 ± 1.06	3.91 ± 1.52	4.53 ± 1.64
4	5.00 ± 1.04*	3.97 ± 1.24	4.56 ± 1.89
5	4.82 ± 0.99	4.03 ± 1.69	5.18 ± 1.65
6	5.21 ± 1.22*	4.28 ± 1.68	5.50 ± 1.69
Mean	4.60 ± 1.01	4.00 ± 1.45	4.68 ± 1.53

* Significantly ($p < 0.05$) different from Week 2.

Table 5: Effects sizes for the change in session ratings of perceived exertion (session-RPE) from week-to-week, and from Week 1 to Week 6, for free sprint (FST), resisted sprint (RST), and plyometrics training (PT) over a six-week period.

Week	FST (n = 9)	RST (n = 9)	PT (n = 9)
Week 1 → 2	0.00	0.18	0.21
Week 2 → 3	0.33	0.08	0.14
Week 3 → 4	0.54	0.04	0.02
Week 4 → 5	0.19	0.04	0.38
Week 5 → 6	0.37	0.15	0.19
Week 1 → 6	*0.93*	*0.34*	*0.88*