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Half-squat or jump squat training under optimum power load conditions to counteract power and speed decrements in Brazilian elite soccer players during the preseason

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Abstract
The purpose of this study was to test which specific type of exercise (i.e., jump squat (JS) or half-squat (HS)) is more effective at maintaining speed and power abilities throughout a preseason in soccer players. Twenty-three male soccer players were randomly allocated into two groups: JS and HS. The mean propulsive power, vertical jumping ability, and sprinting performance were evaluated before and after 4 weeks of a preseason period. The optimum power loads for the JS and HS exercises were assessed and were used as load-references. The soccer players performed 10 power oriented training sessions in total. Both JS and HS maintained power in JS and speed abilities ($P > 0.05$, for main effects and interaction effect) as indicated by ANCOVA. Both groups demonstrated reduced power during HS ($ES = −0.76$ vs. $−0.78$, for JS and HS, respectively); both groups improved acceleration (ACC) from 5 to 10 m ($ES = 0.52$). JS was more effective at reducing the ACC decrements over 0–5 m ($ES = −0.38$ vs. $−0.58$, for JS and HS, respectively). The HS group increased squat jump height ($ES = 0.76$ vs. 0.11, for HS and JS, respectively). In summary, JS is more effective in reducing the ACC capacity over very short sprints while HS is more effective in improving squat jump performance. Both strategies improve ACC over longer distances. New training strategies should be implemented/developed to avoid concurrent training effects between power and endurance adaptations during professional soccer preseasons.

Keywords: football, ballistic, periodisation, sprint, acceleration, concurrent training

Introduction
The ability to perform high-intensity running during match play discriminates soccer teams of different competitive levels (Mohr, Krstrup, & Bangsbo, 2003). The number of accelerations (ACCs) and sprints can be separated from this locomotor category due to its decisive role in defining match outcomes (Faude, Koch, & Meyer, 2012). Players perform approximately 16.6 ± 7.9 sprints (≥ 25.2 km · h$^{−1}$) and 91 ± 21 ACCs (≥ 2 m · s$^{−2}$) per match (Ingebrigtsen, Dalen, Hjelde, Drust, & Wisloff, 2015), highlighting the need to develop the capacity to engage in these high-intensity efforts in the soccer players’ preparation. Sprints and ACCs are involved not only in goal scoring but also in creating space and gaining ball possession. Consequently, these actions may influence technical and tactical aspects of the match.

Soccer players with greater muscle strength and power generally experience lower performance decrements in a match (Silva, Magalhães, Ascensão, Seabra, & Rebelo, 2013). Accordingly, strength and conditioning coaches aim to improve the strength-power and sprinting abilities of the players, especially during the preseason, which is often devoted to the highest levels of physical loading over the entire season in order to develop physicality. In response to this period of concurrent training strategies, some studies have found it possible to improve both neuromuscular and cardiovascular fitness components (Helgerud, Rodas, Kemi, & Hoff, 2011; Wong, Chamari, & Wisloff, 2010; Wong, Chaouachi, Chamari, Dellal, & Wisloff, 2010). However, most studies report no changes or even decrements in sprint and strength-power related abilities in soccer and other team sports players after the preseason (Meckel, Harel,
improvements in maximum strength are required to build the foundation for subsequent power development (Abernethy, Wilson, & Logan, 1995; Issurin, 2010). This is impractical in soccer due to the short duration of the preseason and the high training loads undertaken compared to the competitive season (Jeong, Reilly, Morton, Bae, & Drust, 2011). Hence, stressing training methods instead of periodisation models in order to maintain/increase muscle strength and power in soccer players becomes crucial, principally to concur with the detrimental effects of predominantly aerobic loading in technical, tactical, and physical training (Castagna, Impellizzeri, Chauouchi, & Manzi, 2013).

The optimum power zone constitutes a specific range of loads where both components of the power equation are optimised (i.e., force and velocity (VEL)), which allows athletes to achieve higher values of muscle power in a specific exercise (Cormie et al., 2011b; Mcbride et al., 2002) and adequate for improving performance at both ends of the force–velocity curve (i.e., maximum strength and sprinting) after a specific power-training period (Harris, Cronin, Hopkins, & Hansen, 2008; Loturco, Ugrinowitsch, Roschel, Tricoli, & Gonzalez-Badillo, 2013). Although the effectiveness of optimum power load in increasing athletes’ performance has been systematically established, there is a paucity of data comparing its effects when different types of exercises are executed by elite soccer players. This is especially true when testing its effects on the maintenance of muscle power of the players exposed to the concurrent effects of the predominantly aerobic technical and tactical training typical of soccer. Thus, the purpose of this study was to test which specific type of exercise (i.e., jump squat (JS) or half-squat (HS)) executed under optimum load conditions was more effective at maintaining/improving speed and power abilities throughout an entire preseason in elite soccer players. As the higher values of power are mostly reached under ballistic conditions, we hypothesised that the JS exercise would be more adequate to optimise power and speed gains/maintenance in elite soccer players throughout/after a preseason period.

Methods

Participants

The study sample consisted of twenty-three male Brazilian elite soccer players from the same professional soccer team, randomly allocated to one of
two groups: a JS group (JS: n = 12, age: 23.4 ± 3.6 years, height: 178 ± 6.2 cm, and weight: 75.7 ± 7.6 kg), and a HS group (n = 11, age: 24.1 ± 5.2 years, height: 179 ± 5.5 cm, and weight: 76.2 ± 5.7 kg). There were no dropouts or exclusions for any reason during the study. Prior to commencement of the study, subjects were pair-matched with regard to maximum mean propulsive power and randomly allocated to either the HS or JS by tossing a coin. Pre-tests took place immediately before the preseason. In the season prior to the tests, the soccer team qualified for series A (first division) of the São Paulo State Championship. After being informed of the experimental risks, the soccer players gave written consent to participate in this study. The research was approved by the local Ethics Committee.

**Experimental design**

To test whether a ballistic exercise (i.e., JS) is superior to the HS exercise, the present study evaluated their effects (when executed using optimum power loads) on the power and speed maintenance/improvement of Brazilian elite soccer players during a preseason-training period. The athletes’ mean propulsive power, vertical jumping ability, and sprinting performance were evaluated before (pre) and after 4 weeks of a soccer specific preseason (post). Prior to the beginning of the experimental period, the players’ optimum power loads (i.e., the load that enhances the mean propulsive power production) (Sanchez-Medina, Perez, & Gonzalez-Badillo, 2010) in both the JS and HS were determined and were used as load-references throughout the entire preseason. The athletes were randomly allocated to 1 of 2 training groups: JS exercise or HS exercise. All players had previous experience in strength-power training and a 4-week off-season period prior to the study. Subsequently, a 4-week planned training period took place, as described in Table I. The power training sessions lasted 20 min each, and were scheduled in both periods of the day as planned by the physical trainer. The warm-up comprised 5 min of jogging and smooth stretching exercises. Prior to executing the main exercises, players performed some submaximal movements (2 × 8 with 2-min interval) with respect to the assigned exercise with self-selected loads. Players attended the power training sessions in a non-fatigued state. During this period, all soccer players performed 10 power-oriented training sessions, as follows: (Sessions 1–4) 6 × 8 JS or HS using the optimum power load; (Sessions 5–7) 6 × 6 JS or HS using 1.05 × the optimum power load; (sessions 8–10) 6 × 4 JS or HS using 1.10 × the optimum power load. All power-exercises were performed interspersed by 2-min intervals. This progression took place to account for training-induced changes in the optimum power load, which could not be individually adjusted due to the tight schedule of the team during the preseason. The post-tests were conducted 60 h after the last training session. Players were oriented to attend to the testing session in a fasting state for 2 h, avoiding strenuous exercise and caffeine- and alcohol-containing beverages for 24 h prior to the tests. The total training volume performed by the athletes during the 4 weeks of preseason is presented in Table I.

<table>
<thead>
<tr>
<th>Day</th>
<th>Session</th>
<th>1st week</th>
<th>2nd week</th>
<th>3rd week</th>
<th>4th week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>Morning</td>
<td>–</td>
<td>Rest</td>
<td>Rest</td>
<td>TEC/TAC 70'</td>
</tr>
<tr>
<td></td>
<td>Afternoon</td>
<td>–</td>
<td>PT 20'</td>
<td>Rest</td>
<td>PT 20'</td>
</tr>
<tr>
<td>Tuesday</td>
<td>Morning</td>
<td>–</td>
<td>TEC/TAC 80'</td>
<td>TEC/TAC 90'</td>
<td>TEC/TAC 70'</td>
</tr>
<tr>
<td></td>
<td>Afternoon</td>
<td>–</td>
<td>Rest</td>
<td>PT 20'</td>
<td>Rest</td>
</tr>
<tr>
<td>Wednesday</td>
<td>Morning</td>
<td>TEC/TAC 120'</td>
<td>TEC/TAC 80'</td>
<td>TEC/TAC 80'</td>
<td>TEC/TAC 70'</td>
</tr>
<tr>
<td></td>
<td>Afternoon</td>
<td>PT 20'</td>
<td>PT 20'</td>
<td>Rest</td>
<td>PT 20'</td>
</tr>
<tr>
<td>Thursday</td>
<td>Morning</td>
<td>TEC/TAC 80'</td>
<td>TEC/TAC 80'</td>
<td>TEC/TAC 80'</td>
<td>TEC/TAC (SM) 60'</td>
</tr>
<tr>
<td></td>
<td>Afternoon</td>
<td>Rest</td>
<td>Rest</td>
<td>PT 20'</td>
<td>Rest</td>
</tr>
<tr>
<td>Friday</td>
<td>Morning</td>
<td>PT 20'</td>
<td>PT 20'</td>
<td>Rest</td>
<td>TEC/TAC 60'</td>
</tr>
<tr>
<td></td>
<td>Afternoon</td>
<td>TEC/TAC (SM) 60'</td>
<td>TEC/TAC 60'</td>
<td>PT 20'</td>
<td>Rest</td>
</tr>
<tr>
<td>Saturday</td>
<td>Morning</td>
<td>FM 90'</td>
<td>FM 115*</td>
<td>Rest</td>
<td>FM 80'</td>
</tr>
<tr>
<td></td>
<td>Afternoon</td>
<td>Rest</td>
<td>Rest</td>
<td>Rest</td>
<td>Rest</td>
</tr>
<tr>
<td><strong>Total Weekly Volume (min/%)</strong></td>
<td>TEC/TAC</td>
<td>260' (**67%)</td>
<td>370' (68%)</td>
<td>250' (60%)</td>
<td>330' (70%)</td>
</tr>
<tr>
<td></td>
<td>PT</td>
<td>40' (10%)</td>
<td>60' (11%)</td>
<td>40' (10%)</td>
<td>60' (13%)</td>
</tr>
<tr>
<td></td>
<td>FM</td>
<td>90' (23%)</td>
<td>115' (21%)</td>
<td>125' (30%)</td>
<td>80' (17%)</td>
</tr>
</tbody>
</table>

*Note: TEC, technical training; TAC, tactical training; PT, power training (JS or HS); SM, simulated match; FM, friendly match. **2 halves of 35’ + 1 half of 45’; *1 half of 50’ + 2 halves of 30’; (***) percentage of the total weekly training volume which this type of training represents.*
Due to the training and assessment routines in the club, all soccer players had already been familiarised with the experimental procedures. The order of the assessments was as follows: (Test 1) squat jump and countermovement jump; (Test 2) sprinting speed; (Test 3) mean propulsive power in JS; and (at least 90 min afterwards) (Test 4) mean propulsive power in HS. Prior to the tests, the athletes performed standardised warm-up protocols including general (i.e., running at a moderate pace for 5 min followed by active lower limb stretching for 3 min) and specific exercises. The warm-up was followed by a 3-min interval, after which the players were required to execute the actual tests.

Bar mean propulsive power in JS and HS exercises

Bar mean propulsive power was assessed in the JS and HS exercises (MPPJS and MPPHS, respectively), both being performed on a Smith machine (Technogym Equipment, Italy). The soccer players were instructed to execute three repetitions at maximal VEL for each load, starting at 40% of their BM in the JS and 60% of their BM in the HS. In both exercises, the athletes executed a knee flexion until the thigh was parallel to the ground (≈ 100° knee angle) and, after a command, jumped (for JS) or moved the bar up (for HS) as fast as possible, without their shoulder losing contact with the bar. A load of 10% of BM was gradually added in each set until a decrease in mean propulsive power was observed. A 5-min interval was provided between sets. To determine mean propulsive power, a linear transducer (T-Force, Dynamic Measurement System; Ergotech Consulting S.L., Murcia, Spain) was attached to the Smith machine bar. The bar position data were sampled at 1,000 Hz using a computer, and a finite differentiation technique was used to calculate bar VEL and ACC. The ACC of the bar was multiplied by the bar mass, determining the bar force. The power was calculated as bar force multiplied by bar VEL, thus reflecting the bar power (McBride, Haines, & Kirby, 2011). Mean propulsive power rather than peak power was used in both the JS and HS since Sanchez-Medina et al. (2010) demonstrated that mean mechanical values during the propulsive phase better reflect the differences in the neuromuscular potential between two given individuals. This approach avoids underestimation of true strength potential as the higher the mean VEL (and lower the relative load), the greater the relative contribution of the braking phase to the entire concentric time. We considered the maximum mean propulsive power value obtained in each exercise for data analysis purposes. In order to avoid misinterpretation of the power outputs and considering the changes in body mass which may occur during the preseason in elite soccer players, we normalised these values by dividing the absolute power value by the body mass (i.e., relative power = W · kg⁻¹).

Vertical jumping ability

Vertical jumping ability was assessed using squat and countermovement jumps. In the squat jump, a static position with a 90° knee flexion angle was maintained for 2 s before a jump attempt without any preparatory movement. In the countermovement jump, the soccer players were instructed to perform a downward movement followed by a complete extension of the lower limbs and freely determine the amplitude of the countermovement to avoid changes in jumping coordination pattern. All the jumps were executed with the hands on the hips. Five attempts at each jump were performed interspersed by 15-s intervals. The jumps were performed on a contact platform (Smart Jump; Fusion Sport, Coopers Plains, Australia) with the obtained flight time (i) being used to estimate the height of the rise of the body’s centre of gravity (h) during the vertical jump (i.e., $h = gt^2/8$, where $g = 9.81 \text{ m} \cdot \text{s}^{-2}$). A given jump would be considered valid for analysis if the take-off and landing positions were visually similar. The best attempt was used for data analysis purposes.

Sprinting speed

Prior to the execution of the speed tests, four pairs of photocells (Smart Speed, Fusion Equipment, Brisbane, Queensland, Australia) were positioned at distances of 0, 5, 10 and 20 m along the course. The soccer players sprinted twice, starting from a standing position 0.3 m behind the start line. In order to avoid weather influences, the sprint tests were performed on an indoor running track. A 5-min rest interval was allowed between the two attempts and the fastest time realised was retained for the analyses.

Statistical analysis

Mean and standard deviations were used to represent the centrality and spread of all tested variables. Data normality was checked through visual inspection and the Shapiro–Wilk test. Univariate ANCOVAs were conducted to analyse the changes in the dependent variables scores (power, vertical jumping ability and sprinting speed) and the independent variables by each group (JS or HS) with pre scores as covariates. The significance level was set at
Training using optimum power loads in soccer players

Results

A small reduction in the weight of the athletes in both groups was observed after the preseason period (ES = 0.27 vs. 0.31, for HS and JS, respectively). The jump heights in the SJ and countermovement jump (CMJ) tests, and the mean propulsive power in jump squat (MPPJS) and mean propulsive power in half squat (MPPHS) are presented in Table II. No main effects of groups and moments, or interaction effects, were observed using the ANCOVA (P > 0.05). However, the ES comparisons showed moderate improvement in the SJ height for the HS group (ES = 0.76). Small improvements were found in the MPPJS for both groups (ES = 0.42 vs. 0.44, for HS and JS, respectively). Finally, moderate decrements were observed in the MPPHS for the two groups when comparing the pre and post moments (ES = −0.78 vs. −0.76, for HS and JS, respectively).

Table III demonstrates the VEL at 5, 10 and 20 m and the ACCs from 0 to 5, 5 to 10 and 10 to 20 m in the sprint test. No differences were observed between the JS and HS, or between the pre and post moments in the ANCOVA test. On the other hand, the ES analysis demonstrated small and moderate reductions in the VEL 5 m for the HS (ES = −0.58) and JS (ES = −0.39), respectively. Small reductions were also observed in the VEL at 10 m in the HS (ES = 0.31). In the ACC 0–5 m small and moderate decreases were found for the JS (ES = −0.38) and HS (ES = −0.58), respectively. Finally, in the ACC 5–10 m moderate improvements were observed for both groups (ES = 0.52 for both groups).

Discussion

The primary aim of this study was to test whether different types of exercise (i.e., JS or HS) performed

Table II. Jump height and mean propulsive power in the JS and HS pre and post four weeks of preseason power oriented training under optimum load conditions using HSs or JSs in elite soccer players.

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre</th>
<th>Post</th>
<th>Δ% (95% CI)</th>
<th>ES (Rating)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SJ (cm)</td>
<td>39.68 ± 3.51</td>
<td>40.08 ± 3.68</td>
<td>1.18 (−2.30; 4.65)</td>
<td>0.11 (Trivial)</td>
</tr>
<tr>
<td>HS</td>
<td>39.55 ± 3.05</td>
<td>41.88 ± 4.17</td>
<td>5.83 (2.71; 8.94)</td>
<td>0.76 (Moderate)</td>
</tr>
<tr>
<td>CMJ (cm)</td>
<td>41.58 ± 3.55</td>
<td>41.78 ± 4.60</td>
<td>0.37 (−2.17; 2.91)</td>
<td>0.06 (Trivial)</td>
</tr>
<tr>
<td>MPPJS (w)</td>
<td>9.47 ± 1.27</td>
<td>10.03 ± 1.20</td>
<td>−0.91 (−3.58; 1.76)</td>
<td>0.42 (Small)</td>
</tr>
<tr>
<td>MPPHS (w)</td>
<td>9.23 ± 0.60</td>
<td>8.78 ± 1.08</td>
<td>−14.25 (−16.64; −8.26)</td>
<td>−0.76 (Moderate)</td>
</tr>
</tbody>
</table>

Table III. Sprint test performances pre and post 4 weeks of preseason power oriented training under optimum load conditions using HSs or JSs in elite soccer players.

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre</th>
<th>Post</th>
<th>Δ% (95% CI)</th>
<th>ES (Rating)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VEL 5 m (m ⋅ s⁻¹)</td>
<td>4.79 ± 0.17</td>
<td>4.72 ± 0.21</td>
<td>−1.34 (−3.5; 0.8)</td>
<td>−0.39 (Small)</td>
</tr>
<tr>
<td>VEL 10 m (m ⋅ s⁻¹)</td>
<td>5.68 ± 0.17</td>
<td>5.65 ± 0.18</td>
<td>−0.15 (−0.76; 0.49)</td>
<td>−0.17 (Trivial)</td>
</tr>
<tr>
<td>VEL 20 m (m ⋅ s⁻¹)</td>
<td>5.56 ± 0.20</td>
<td>5.50 ± 0.20</td>
<td>−1.10 (−0.37; 0.16)</td>
<td>−0.31 (Small)</td>
</tr>
<tr>
<td>ACC 0–5 m (m ⋅ s⁻¹)</td>
<td>4.69 ± 0.32</td>
<td>4.46 ± 0.39</td>
<td>−2.53 (−6.80; 1.74)</td>
<td>−0.38 (Small)</td>
</tr>
<tr>
<td>ACC 5–10 m (m ⋅ s⁻¹)</td>
<td>4.35 ± 0.36</td>
<td>4.14 ± 0.38</td>
<td>−4.75 (−8.28; −1.20)</td>
<td>−0.58 (Moderate)</td>
</tr>
<tr>
<td>ACC 10–20 m (m ⋅ s⁻¹)</td>
<td>0.85 ± 0.09</td>
<td>0.86 ± 0.08</td>
<td>−0.65 (−3.07; 1.78)</td>
<td>0.03 (Trivial)</td>
</tr>
</tbody>
</table>

Note: VEL, velocity; ACC, acceleration; Δ%, mean percentage of difference; CI, confidence interval; ES, effect size.
using optimum power loads are capable of avoiding the power and speed decrements that frequently occur following a preseason conditioning programme in elite soccer players. It was hypothesised that the JS would be more adequate for maintaining/improving these neuromuscular abilities in this group of athletes. The main findings of this investigation were threefold: (1) both the JS and HS executed under optimum power load conditions were effective at maintaining power in the JS ballistic condition (moving lower loads at higher VELs) and speed abilities in elite soccer players; however, in the post-test, both groups presented reduced values of power when having to move higher loads at lower VELs during HSs (ES = -0.76 vs. -0.78, for JS and HS, respectively); (2) both groups improved ACC capacity from 5 to 10 m (ES = 0.52), although the JS was more effective at reducing the ACC decrements from 0 to 5 m (ES = -0.38 vs. -0.58, for JS and HS, respectively); (3) both exercises were adequate for avoiding vertical jump height reduction, although only the HS caused enhancement in squat jump height, when analysed by ES magnitudes (ES = 0.76 vs. 0.11, for HS and JS, respectively).

Traditional strength training is based on percentages of 1-RM (Channell & Barfield, 2008; Fleck, 1999) and this measurement is not common in professional soccer training routines, mainly during short pre-seasons, due to its’ time-consuming, volitional engagement and inherent risk characteristics. Therefore, we opted to use optimum power loads instead of traditional periodisation since Loturco, Ugrinowitsch, Roschel, Tricoli, et al. (2013) demonstrated that this training model is able to improve power and speed abilities, without hampering maximum strength adaptations. It should be emphasised that, as in the cited reference (Loturco, Ugrinowitsch, Roschel, Tricoli, et al., 2013), we used the power outputs collected from the barbell, which do not reflect the actual VEL of body centre of mass during a given movement, possibly resulting in different values of power and training loads (Cormie, McCaulley, Tripplett, & McBride, 2007; Lake, Lauder, & Smith, 2012; McBride et al., 2011). Nevertheless, our results confirmed the efficiency of the bar optimum power loads in improving ACC capacity at longer distances (from 5 to 10 m, ES = 0.52), and independent of the exercise performed (i.e., JS or HS). However, both exercises were unable to increase power and speed outcomes after the experimental period and this could be partially explained by the concurrent effects of endurance and strength adaptations (Docherty & Sporer, 2000; Helgerud et al., 2011; Kraemer et al., 2004), which typically occur during a professional soccer pre-season. Other parameters of physical fitness, especially those related to aerobic power and aerobic capacity, could have benefited from the soccer pre-season combined with power training (Hickson, 1980). However, we did not address these measures in the present study.

Although the 20 m average speed did not change in relation to the pre-tests, our soccer players presented important alterations in sprinting dynamics. In spite of the aforementioned ACC improvements at longer distances (ES = 0.52 for both groups, from 5 to 10 m), the ballistic condition (i.e., JS) appeared to be more indicated for developing the kinematic aspects of the specific soccer speed over very-short distances. When compared to the JS, the HS performed using the optimum power load produced higher decrements in speed/ACC from 0 to 5 m (ES = -0.38 and -0.58, for JS and HS, respectively). Accordingly, Newton et al. (2006) reported similar efficiency of JSs (performed using the optimum power load) in reducing the decreases in speed-related variables in elite female athletes. It is important to emphasise that the ACC rate over very short-distances is highly associated with maximum strength levels (Comfort, Haigh, & Matthews, 2012; Comfort, Stewart, Bloom, & Clarkson, 2014; McBride et al., 2009; Wisloff, Castagna, Helgerud, Jones, & Hoff, 2004), since to break the momentum of inertia and accelerate as fast as possible, a soccer player has to apply a great amount of force against the ground. As both exercises were ineffective at improving the power outcomes and due to the strong relationship between this variable and maximum strength (Sáez de Villareal, Requena, Izquierdo, & Gonzalez-Badillo, 2013; Stone, O’Bryant, et al., 2003; Stone, Sanborn, et al., 2003), it is conceivable that the players’ maximum strength performance did not alter during the experimental period. It may be highlighted after analysing the negative ES (≈-0.78) presented by both groups in HS power output at the end of the pre-season. These results suggest that the players’ ability to apply force against higher loads at lower VELs could have been affected, and this is moderately correlated with the capacity to accelerate from a zero-velocity (Barr, Sheppard, Agar-Newman, & Newton, 2014; Comfort, Bullock, & Pearson, 2012). As a result, they did not increase their ACC capacity from 0 to 5 m. Finally, the superiority of JS in reducing the ACC decrements over very-short distances could be associated with the mechanical characteristics of ballistic exercises and their similarity with sprint-movement patterns. For instance, strength-power exercises with jumping tasks allow both projection and lifting of the soccer players and have ACC and deceleration phases (Newton & Kraemer, 1994; Sáez de Villareal et al., 2013).

The absence of improvement in VEL over 20 m and the decrease in ACC from 0 to 5 m in response
to the preseason should be viewed with concern in contemporary soccer. The analysis of the evolution of physical performance parameters in the English Premier League revealed a linear increase in the high-intensity run and sprint distance across the 2006–07 and 2012–13 seasons (Barnes, Archer, Hogg, Bush, & Bradley, 2014). This detailed observation shows an increased number of total sprints, together with an increase in the proportion of explosive sprints (i.e., entry into the sprint zone with no excursion into the high-speed zone in the previous 0.5 s period) (from 31 ± 14 vs. 57 ± 20%) to the detriment of leading sprints. Across the same period, the average distance covered per sprint decreased (6.9 ± 1.3 vs. 5.9 ± 0.8 m, P < 0.001; ES = 0.91), with a concomitant increase in the maximal running speed (9.12 ± 0.43 to 9.55 ± 0.40 m · s⁻¹). These findings highlight the importance of developing and maintaining ACC characteristics over very-short distances, eliciting high strength-power characteristics. Therefore, training strategies which allow for enhanced endurance along with improved strength, power and speed abilities need to be adequately addressed in soccer, as previous studies have also shown impaired neuromuscular performance after the preseason in soccer players (Mercer et al., 2014; Taylor et al., 2012). This can be regarded as the concurrent effect of being involved in high volumes of technical-tactical training and endurance physical training (Coutts, Reaburn, Piva, & Rowsell, 2007), with inadequate recovery (Coutts & Reaburn, 2008), and low volumes of exposure to strength-power training (Hoffman et al., 1991; Newton et al., 2006). It is possible that with a tapering period, power and speed abilities would recover, and manifest as better functional performance than prior to the preseason (Mujika & Padilla, 2003). However, in soccer and other team sports, tapering is not a common practice and players probably initiate the competitive season in an overreached state (Kraemer et al., 2004).

As for vertical jumping ability, both exercises were able to avoid decrements in SJ and CMJ performance. However, HS was capable of producing greater ES than JS in SJ height in the direction of performance improvement (ES = 0.76 and 0.11, for HS and JS, respectively). It is likely that the heavier loads used in HS in order to reach the optimum power zone produced important and positive adaptations in muscle contractile properties, directly responsible for the players’ performance in the SJ (Lamas et al., 2012). On the other hand, the absence of improvements in the CMJ for both groups could be associated with the negative effects of the very-high training volume performed by the soccer players (presented in Table II) in the stretch-shortening cycle and the role of this cycle on CMJ performance (Coutts, Slattery, & Wallace, 2007; Komì, 2000).

We acknowledge that our study is limited by the recruitment of participants only to two groups of power-based training. The addition of a third group composed of participants performing strength training (≥85% 1-RM) could have led to distinct effects. However, our main focus in this study was to elucidate whether specific types of exercise with small biomechanical variation in their execution (JS or HS) would result in different power and speed adaptations in soccer players. In addition, a control group would have permitted the isolation of the intervention effects from the training effects expected during regular soccer training.

To conclude, the findings presented herein are in line with a number of previous studies that have investigated the neuromuscular adaptations that occur in professional soccer players after a preseason period (Faude, Schnitker, Schulte-Zurhausen, Müller, & Meyer, 2013; Mercer et al., 2014; Ostojic, 2003; Taylor et al., 2012; Wahl, Güldner, & Mester, 2014). Furthermore, these results are in accordance with the outsized quantity of unpublished data collected in our sports laboratory, showing significant impairments in neuromechanical capacities presented by team-sports athletes after pre-seasons with high-training volume, independent of the strength-training regimen adopted. Since speed and power abilities play an important role in professional soccer performance, head coaches and technical staff should consider revising their technical and tactical training practices in order to reduce the players’ exposure to concurrent training effects (Jones, Howatson, Russell, & French, 2013). Moreover, strength and conditioning coaches must develop training strategies with higher volumes and frequencies of strength-power training sessions, to diminish the significant difference between the large endurance-power training volume and the low strength-training volume commonly performed by the soccer players during the preseason (Ramírez-Campillo et al., 2014; Ronnestad, Kvamme, Sunde, & Raastad, 2008). It should be recognised though that many teams do not have the possibility of regularly performing strength training during the different training cycles. Hence, adopting more effective methods is crucial to maximise neuromuscular adaptations in elite soccer players with congested training and match schedules. Finally, monitoring strategies have to be implemented in the training routines to avoid symptoms of over-reaching and overtraining, as exemplified by the use of questionnaires like the Recovery-Stress Questionnaire for Athletes (Coutts & Reaburn, 2008; Di Fronso, Nakamura, Bortoli, Robazza, & Bertollo, 2013; Faude, Killmann, Ammann,
Schnittker, & Meyer, 2011) and objective blood measures (Heisterberg et al., 2013), although the latter remain questionable (Meyer & Meister, 2011). Monitoring changes in performance per se, with simple and non-exhaustive tests, may also assist strength and conditioning coaches to detect early signs of overreaching, but specific and sensitive tools in soccer remain to be established.

References


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