

# SPECIFICITY OF STRENGTH TRAINING EXERCISES DURING CONCURRENT RESISTANCE AND SPRINT/JUMP TRAINING

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## INTRODUCTION

Adaptations to resistance training (RT) are often shown to be specific to the movement patterns (Wilson et al., 1996) and velocities (Caiozzo et al., 1981) of the training exercises. However, in most studies RT has not been performed concurrently with other types of training (e.g. speed training). Moreover, in those studies where concurrent training has been performed, a comprehensive assessment of neuromuscular changes has not been presented. The purpose of this series of studies was ultimately to describe neuromuscular and performance adaptations to concurrent speed- and resistance training when RT exercises had either similar or dissimilar movement patterns to running and jumping tasks.

## METHODS

The research consisted of two main studies and two reliability/validation studies. In the first study, 8 strength-trained men were filmed (200 Hz) while performing several variations of standing broad jump (BJ), countermovement vertical jump (VJ), 'traditional' squat (SQ), jump-squat (JSQ) and forward hack squat (FHS; Figure 1) tasks. Hip, knee and ankle joint angular displacements, velocities and accelerations were calculated after digitising joint markers from video using Peak Motus software (Peak Performance Technologies, USA).

In the second study, 15 men and 8 women were allocated to one of 3 training groups: 1) squat lift + sprint/jump (both twice a



**Figure 1:** The forward hack squat (FHS) exercise.

week), 2) FHS + sprint/jump (both twice a week) or 3) sprint/jump only (4 times a week). Before and after 5 weeks of training subjects' 20 m sprint, VJ, FHS (with load of 40 and 70% of predicted 1 RM) and SQ (with load of 30 and 60% of predicted 1 RM) performances were tested. Additional tests included isokinetic knee extensor torque (30 and 180°·s<sup>-1</sup>), muscle thickness, pennation and fascicle length estimation of the vastus lateralis (VL) and rectus femoris (RF) muscles, and EMG quantification of 8 major lower limb muscles during the performance of sprint and VJ tasks.

In two further studies the reliability of the isometric SQ and FHS were examined (ICC > 0.97), as were correlations with their dynamic counterparts (1 RM:  $r > 0.76$ ;  $p < 0.01$ ). They were deemed useful in predicting 1RM for the purposes of setting training loads. Reliability of the dynamic FHS at 70% (ICC<sub>unilateral</sub> = 0.90; ICC<sub>bilateral</sub> = 0.95) and 40% (ICC<sub>unilateral</sub> = 0.70; ICC<sub>bilateral</sub> 0.64) of predicted 1 RM was also examined. Given the reliability of the FHS tests they could be used (with the SQ) in the second study (described above).

## RESULTS AND DISCUSSION

The first study was designed to assess similarities and differences between several RT exercises and sporting tasks such as VJ and BJ. The kinematics of the VJ (with arms crossed over the chest) and JSQ (with a load of 60% bodyweight) were very similar. There was little similarity however between the 'traditional' SQ and VJ. The kinematics of the concentric phases of BJ and FHS were not similar, although the kinematics of the FHS appeared similar to those of the acceleration phase of the sprint run as reported by Jacobs & Ingen Schenau (1992). We concluded that the VJ & JSQ and sprint & FHS tasks had similar movement patterns.

The hypothesis of the second study was that subjects would improve most in tests (i.e. VJ or sprint) that had movement patterns similar to the RT exercises used in training (i.e. JSQ or FHS). Despite a collective improvement in many of the tests, there were no significant differences between the three training groups in their improvements in VJ, sprint, FHS or SQ tests. Given that subjects who performed JSQ and FHS training did not improve more in VJ and sprint tests respectively, we conclude that there was no significant movement pattern-specific training effect. There were also no differences between groups in torque produced at 30 & 180°.s<sup>-1</sup> in isokinetic knee extension suggesting that the addition of RT did not significantly affect velocity-specific strength. Thus specific adaptations did not occur as rapidly as in past studies where RT was performed by itself.

Despite these results, there was a trend toward JSQ subjects producing maximum knee extension torque at more closed knee angles than FHS subjects after the training. This might be explained by the differences in knee ROM during training. There was also some evidence that intermuscular

coordination (EMG) differed between resistance and sprint/jump subjects after training, although only a small number of subjects were tested (N = 10). More significantly, subjects who performed JSQ or FHS training showed greater muscle pennation and shorter fascicle lengths in the VL while the opposite was true for subjects who only performed sprint/jump training. These changes are consistent with those presented in previous studies (i.e. higher force/lower velocity = larger pennation and shorter fascicles) and suggest that rapid muscle architecture adaptations specific to the speed of training can occur. While muscle thickness increased in RF, no significant pennation or fascicle length changes occurred. Given that length changes in RF are small the velocity of contraction might be important for architectural adaptations.

## SUMMARY

There appeared to be no training-specific performance changes in subjects performing concurrent resistance and/or speed/jump training for 5 weeks. Significant muscle architecture changes, and small changes in EMG and angle-related knee extension torque suggest however that longer-term adaptations may be specific to the RT performed in concurrent training regimes.

## REFERENCES

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