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Effects of different arm-specific training on the pull-up performance of climbers

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INTRODUCTION:
Sport climbing performance is known to be highly related to strength and endurance in upper limb. Trainers and climbers therefore focus on developing the ability of the fingers to hang on holds and the arms to pull up from one position to another. Although finger-specific assessment and training methods are widely analysed in the literature, no study has yet quantified the effects of arm-specific training. These programs usually consist of different muscle contraction regimes (isometric, eccentric…). The aim of this study is then to compare the effects of these different types of training on climbers pull-up capabilities.
METHODS:
35 advanced to high-elite climbers (23±7y/o; 176±8cm; 62±8kg) performed 5 weeks of training (twice a week) based on pull-ups on hangboard, and were randomly divided into 4 different groups: eccentric (ECC; n=9), stato-dynamic (SD; n=9), plyometric (PLYO; n=9) and no specific trainings (CTRL; n=8). Before and after training, they were tested on a force-sensing hangboard (SmartBoard, France). Force, velocity, muscle power and muscle work were analysed during 3 various pull-up exercises: pull-ups at body weight ("jump tests" with or without coordination, or preceded by a descending phase), incremental weighted pull-ups and maximal number of pull-ups ("exhaustion test"). These tests were used to characterize the climber's abilities (body coordination skills, concentric capabilities of arm muscles, force-velocity profile and capacity to resist fatigue). The comparison between groups before and after training were assessed by ANOVAs with post-hoc tests and principal component analysis (PCA).
RESULTS:
Performance between the pre- and post-tests was similar in the CTRL group, but significantly improved after training in the SD, PLYO and ECC groups. Significant interaction effects were found, showing that improvements varied according to the training programs. Especially, the training programs differed in their effects on the velocity parameters during jump tests (+27±11% with PLYO) which led to a greater muscle power, on a higher maximum load during weighted pull-ups (+5±2% with ECC) and on the maximum number of pull-ups (+21±19% with PLYO) and muscle work (+34±17% with PLYO) during the exhaustion test. To summarize, the evolution of each participant on a 2-factor PCA was quantified and showed that the effects of training depended both on the training type (either PLYO, ECC or SD) and on the individual characteristics prior to the training.
CONCLUSION:
This study pointed out that the muscle contraction regimes used during the arm training programs affected the benefits. It seemed that ECC improved force variables, PLYO enhanced velocity and endurance parameters whereas SD had lower effects. Overall, all program effects were dependent on the individual initial characteristics. This study provided new quantification and knowledge that is available to trainers and climbers to help them optimise their improvements.

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