Official title: Effects of a dynamic versus an isometric Copenhagen Adduction exercise on muscle strength and athletic performance in youth football: A randomized controlled trial

NCT number: NCT ID not yet assigned

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Methods

Inclusion criteria

Healthy male players aged between 12 and 16 years old systematically (≥4 times per week) participating in training and games will be eligible for inclusion.

Exclusion criteria

(1) musculoskeletal injury and/or neurological disorder that would affect strength and/or athletic performance testing, and/or the exercise execution.

(2) adductor muscle injury within 6 months before study initiation.

(3) pain greater than 2/10 on a Numeric Rating Scale (NRS) during strength and/or athletic performance testing, and/or during the intervention.

(4) any systematic strength training of the adductor muscles during the last month prior to study initiation.

Ethics

Ethical approval was obtained from University of West Attica ethics committee (60372/01-07-2025) and all players gave their written informed consent prior to inclusion in accordance with the Declaration of Helsinki. The research was prospectively registered to ClinicalTrials.gov (https://clinicaltrials.gov/).

Randomization

Randomization will be performed before baseline testing with the use of an online software (https://randomizer.org/) by a person that will not otherwise be involved in the study. The randomization result for each participant will be placed in a numbered sealed opaque envelope and be given to the physiotherapist and the exercise therapist who will supervise the intervention. The group allocation will be announced to every participant the day of the first exercise session.

Blinding

The strength and athletic performance testing will be performed by a physiotherapist and an exercise therapist, respectively. They will not participate in the intervention supervision and will be unaware of the group allocation. The physiotherapist and the exercise therapist who will supervise the intervention, as well as the participants, will not be aware of the testing results until the completion of the study.

Training groups

The participants will be assigned to either a dynamic (DCA) or an isometric (ICA) Copenhagen Adduction exercise group and will perform a progressive exercise protocol for 6 weeks during

the in-season of the team at the club's training facilities. Both exercises will be performed twice per week with a 48-hour rest between them.

Dynamic Copenhagen Adduction exercise (DCA)

The CA is performed with the athlete lying on the side. His forearm is used for support on the ground while the other hand rests on the pelvis. The partner supports the training leg by keeping it at the height of their pelvis and holding it with one hand placed under the knee and the other under the ankle Then the athlete brings the hip of the training leg into adduction until the thigh and the torso form a straight line, while the hip of the other leg is also adducted. Then the hip of the training as well as the non-training leg come into abduction. The non-training leg touches the ground without supporting the body. The duration of the entire movement is 6 seconds (3 seconds of concentric and 3 seconds of eccentric contraction). To ensure correct execution of the exercise, flexion, lateral flexion and rotation movements of the torso and/or hip are avoided. The athlete's effort is supported by vocal instructions from the supervisor. The athlete performs the exercise on both sides.

Isometric Copenhagen Adduction exercise (ICA)

The isometric Copenhagen adduction exercise will be performed in three progression levels. In the first level, the athlete's training leg is placed on a box with support under the medial surface of the knee, the hip of the non-training leg in adduction, and the knee at 90 degrees of flexion.[12] In the second level, the training leg is placed on a box with support under the medial malleolus, the hip of the non-training leg in abduction, and the knee at 90 degrees of flexion. In the third level, the training leg is placed on a box with support under the medial malleolus, the hip of the non-training leg in adduction, and the knee at 90 degrees of flexion. The athlete's forearm is used for support, while the other hand rests on the pelvis. The duration of each repetition will be 6 seconds. To ensure correct execution of the exercise, flexion, lateral flexion and rotation of the trunk and/or hip will be avoided. The athlete's effort will be supported by vocal instructions from the supervisor. The athlete performs the exercise on both sides. The height of the box which will be used will be 40 cm. In cases where the athlete's humerus is shorter, a 30 cm box will be used.

Training Load

We will attempt to keep the two exercises as similar as possible throughout the study by keeping the same total repetition number and time under tension, using 2 sets of 6-12 repetitions per side for both exercises. For the DCA, the increase of the repetition number will be the only progression parameter. For the ICA, the lever of the training leg will be used as an additional progression component.

Outcome measures

The primary outcome measures will be maximal eccentric (EHAD) and isometric (IHAD) hip adduction torque. The secondary outcome measures will be jump (squat jump, countermovement jump, countermovement jump with arm swing) and sprint (5m, 10m, 20m) capacity, delayed onset muscle soreness (DOMS), and perceived exertion. Torque will be

measured using a digital handheld dynamometer (Activforce 2, ActivBody, California, USA) and standardized strength testing (unilateral supine eccentric adduction strength test, unilateral supine isometric adduction strength test). Jump and sprint capacity will be measured using the Microgate Optogait (Microgate, Bolzano, Italy) and Fitlight System (Fitlight USA Inc., Miami, Florida), respectively. Perceived exertion will be recorded for each exercise using the Borg CR10 scale. DOMS will be recorded before the start of each exercise session, referring to the previous session, with the use of a numerical ranking scale (0-10).

Statistical analysis

Statistical analysis will be performed using SPSS Statistics (v26, IBM Corporation). Baseline and follow-up values will be presented as mean ± standard deviation (SD). For torque, jump, and sprint analysis, the highest value will be used. One-way ANCOVA will be used for between-group differences on the dependent variables (EHAD, IHAD, jump, sprint), while paired samples t-test will be used to determine the difference between baseline and follow-up values for the dependent variables (EHAD, IHAD, jump, sprint). Repeated measures ANOVA with Bonferroni correction will be used to determine the difference between groups for DOMS and perceived exertion. Athletes with compliance less than 75% of the total number of sessions will be excluded from the statistical analysis. Effect size (Cohen's d) is calculatedwill be set as small (0.2), moderate (0.5), and large (0.8), while statistical significance as $p \leq 0.05$.