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None declared.

Effects of eccentric exercise on muscle architecture in adults: A systematic review

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Review question / Objective: **Question: What is the effect of eccentric training on muscle architecture in the adult population? Objective: This review aims to evaluate the effects of eccentric training on muscle architecture in the adult population.**
Condition being studied: **Healthy individuals who were subjected to eccentric training.**
Eligibility criteria: **Articles that met the following criteria were included in this review: (I) subjects >18 years old, (II) Eccentric training program longer than 4 weeks (III) Studies with randomized clinical trial design, (IV) studies reporting measures of muscle architecture: "pennation angle", "fascicle length", "muscle thickness", (V) full text available, and (VI) articles in English. In addition, we excluded all those articles that (I) Eccentric training programs of less than 4 weeks (II) conference presentations, theses, books, editorials, review articles and expert opinions, (III) duplicate articles, and (IV) articles in which the principal or secondary authors did not respond to e-mail requests.**

INPLASY registration number: This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 21 December 2021 and was last updated on 21 December 2021 (registration number INPLASY2021120094).

INTRODUCTION

Review question / Objective: **Question: What is the effect of eccentric training on muscle architecture in the adult population? Objective: This review aims to evaluate the effects of eccentric training on muscle architecture in the adult population.**

Rationale: **To understand in greater depth, the situation of skeletal muscle in sports or injury rehabilitation contexts, it is necessary to know the characteristics of muscle tissue in a broader and more functional sense (Suchomel et al., 2016). One of the most objective and global concepts that contemplate the physiological and functional capacity of**

this tissue is muscle quality (MQ) (Fragala et al., 2014). Its evaluation can provide us with the muscle's capacity to generate strength, power, or functionality (Jerez-Mayorga et al., 2020). Muscle quality is composed of four dimensions (muscle composition, architecture, ultrastructure, and functional unit) and two indexes (relative strength and muscle quality index), with architecture being one of the least explored factors (Fragala et al., 2015). Muscle architecture (MA) is defined as the arrangement of muscle fibers within a muscle about the axis of force generation, becoming one of the most determinant components of muscle function, which can be associated with functional and health components in individuals (Lieber & Fridén, 2000; Lieber & Ward, 2011; Naimo et al., 2021). Therefore, MA is a fundamental element to be considered in assessing MQ (Naimo et al.). There is variability in the architecture of a muscle; however, generally, two types of architectural arrangements are described, longitudinal muscles (muscle fibers are arranged parallel to the force-generating axis) and pennate muscles (fibers are oriented at one or more angles concerning the force-generating axis) (Lieber & Fridén; Lieber & Ward). Several parameters can be considered; however, these are often conditioned by the assessment method used (citation). These parameters include muscle thickness (MT); muscle length (ML), fascicle length (FL), pennation angle (PA), and physiological cross-sectional area (PSCA, the latter two being most closely related to muscle force generation (Lieber & Fridén; Lieber & Ward). Understanding the architectural adaptations of skeletal muscle to different types of training has not yet been established by the scientific community. This could favor the recovery processes in the face of muscular injuries or even prevent them (Blazevich & Sharp 2005). Several studies have attempted to determine the modifications of the architectural parameters in front of different exercise programs; however, it is still not clear which is the best type of exercise to produce effective changes in these parameters (Narici et al., 2016). Recently Gerard et al. (2020), through a meta-analysis, determined the effects of eccentric exercise on the muscular architecture of the long head of the biceps femoris, concluding that it produces adaptations by increasing its MT, FL and decreasing the PA, as well as producing adaptations in the strength of the hamstring muscles.

Condition being studied: Healthy individuals who were subjected to eccentric training.

METHODS

Search strategy: The search was performed by two authors (RL-P and DJ-M). The databases used were Pubmed, Scopus, SPORTDiscus and Web of Science. The search was performed from inception until March 2021. The following keywords were included: “eccentric training”, “eccentric contraction", “eccentric exercise”, “lengthening contraction”, “negative work”, “muscle architecture”, “pennation angle”, “fibre length”, “fiber length”, “fascicle length”, “cross-sectional area”, “muscle thickness”. The search was not limited in years.

Participant or population: Subjects >18 years old.

Intervention: Eccentric training program longer than 4 weeks.

Comparator: Control group, another type of exercise.

Study designs to be included: Studies with randomized clinical trial design.

Eligibility criteria: Articles that met the following criteria were included in this review: (I) subjects >18 years old, (II) Eccentric training program longer than 4 weeks (III) Studies with randomized clinical trial design, (IV) studies reporting measures of muscle architecture: “pennation angle”, “fascicle length”, “muscle thickness”, (V) full text available, and (VI) articles in English. In addition, we excluded all those articles that (I) Eccentric training programs of less than 4 weeks (II) conference

presentations, theses, books, editorials, review articles and expert opinions, (III) duplicate articles, and (IV) articles in which the principal or secondary authors did not respond to e-mail requests.

Information sources: Electronic databases: Pubmed, Scopus, SPORTDiscus, and Web of Science.

Main outcome(s): The most relevant results for this review are the parameters of muscle architecture (pennation angle, fascicle length, physiological cross-sectional area, and muscle thickness) that have been measured and quantified through imaging techniques such as B-mode ultrasound or magnetic resonance imaging.

Additional outcome(s): None.

Data management: An Excel template will be used for data extraction for each manuscript selected for review. The following information will be considered: author, year, aim, architectural parameter, sample size, age, population, physical activity level, number of participants, eccentric training protocol, results, and conclusions.

Quality assessment / Risk of bias analysis: The quality of the evidence of the articles included in this review was assessed using the PEDro scale, which is based on criteria that identify whether the RCTs have sufficient internal validity and statistical information to interpret the results (external validity (item 1), internal validity (items 2-9) and statistical reporting (items 10-11). Each item is classified as yes or no (1 or 0) according to whether the criterion is clearly met in the study. The total score is from item 2 to 11, so the maximum score is 10 (Cashin, AG et al., 2020). Two independent investigators (RL-P and DJ-M) evaluated the articles using this scale. In case of discrepancy, a third evaluator (LC-R) was consulted. In relation to the quality of evidence, it has been suggested that scores < 4 are considered poor quality, 4 - 5 moderate, 6 - 8 good, and 9 - 10 excellent. (Cashin, AG et al.).

Strategy of data synthesis: The data will be analyzed qualitatively.

Subgroup analysis: Not applicable.

Sensitivity analysis: Not applicable.

Language: Only articles in English were included for this review.

Country(ies) involved: Chile, España.

Other relevant information: None.

Keywords: Muscular architecture; Eccentric training; Muscle power; Pennation angle; muscle thickness; Muscle quality.

Dissemination plans: The systematic review is expected to be submitted to a scientific journal for data dissemination.

Contributions of each author:

Author 1 - Rodrigo Lizama-Pérez - writing the manuscript, filtering the studies, and reviewing the studies.
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Author 2 - Ignacio Chirosa-Ríos - Provided feedback and approved the final manuscript.
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