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Full Length Article

Influence of chronic stretching on muscle performance: Systematic review

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ABSTRACT

The aim of the current study was to investigate the influence of chronic stretching on muscle performance (MP) by a systematic review. The search strategy included MEDLINE, PEDro, Cochrane CENTRAL, LILACS, and manual search from inception to June 2016. Randomized and controlled clinical trials, non-randomized, and single group studies that have analyzed the influence of flexibility training (FT) (using any stretching technique) on MP were included. Differently, studies with special populations (children, elderly, and people with any dysfunction/disease), and articles that have used FT protocols shorter than three weeks or 12 sessions were excluded. The MP assessment could have been performed by functional tests (e.g. jump, sprint, stretch-shortening cycle tasks), isometric contractions, and/or isotonic contractions. Twenty-eight studies were included out of 513. Seven studies evaluated MP by stretch-shortening cycle tasks, Ten studies evaluated MP by isometric contractions, and 13 studies assessed MP by isotonic contractions. We were unable to perform a meta-analysis due to the high heterogeneity among the included studies. In an individual study level analysis, we identified that 14 studies found positive effects of chronic stretching on MP. The improvements were observed only in functional tests and isotonic contractions, isometric contractions were not affected by FT. Therefore, FT might have an influence on dynamic MP. However, more studies are necessary to confirm whether FT can positively affect MP.

1. Introduction

Stretching is a fundamental component of most training routines, and it is a strategy generally employed when the goal is to enhance muscle flexibility (Ayala, Sainz de Baranda, De Ste Croix, & Santonja, 2013; Marshall, Cashman, & Cheema, 2011). Flexibility, which refers to the ability of a muscle (group) to elongate (Magnusson, Simonsen, Aagaard, Srensen, & Kjaer, 1996), is an important component of physical fitness, and it has an intimate relation with muscle performance (MP).

Stretching can affect MP in different ways depending on how it is executed. The acute effects of stretching have been widely investigated in the last decade. A considerable amount of original studies (Costa, Herda, Herda, & Cramer, 2014; Cramer et al., 2007), and reviews (Behm & Chaouachi, 2011; Kay & Blazevich, 2012) have evidenced that a bout of stretching may provoke deleterious effects on MP. With respect to the chronic effects of stretching, it is well documented its effectiveness in increasing muscle flexibility (Medeiros, Cini, Sbruzzi, & Lima, 2016). However, the influence of such flexibility improvement on MP remains an issue of debate.

The theories that seek to explain the role of flexibility on MP are suggestive. It is believed that chronic stretching can decrease muscle stiffness (Wilson, Elliott, & Wood, 1992), induce an increase in Ca^{+} within the neuromuscular junction (Yamashita,

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Ishii, & Oota, 1992), and promote sarcomerogenesis (De Deyne, 2001). All these factors may contribute to a possible enhancement in MP after flexibility training (FT). In the present review, FT refers to exercise routines involving chronic stretching.

The literature is scarce on this topic, to the best of the authors' knowledge, there are only two review studies (Rubini, Costa, & Gomes, 2007; Stone et al., 2006) that attempted to elucidate the role of FT on MP. However, both studies employed a narrative approach and provided insufficient information on the topic. Furthermore, we are aware of a number of studies that have been published in the last decade. Therefore, a review study with more appropriate methodology would contribute to better understand the relationship between FT and MP. Hence, the purpose of the current investigation is to analyze the influence of FT on MP by means of a systematic literature review.

2. Methods

The current study utilized PRISMA (Preferred Reporting Items for Systematic Review and meta-analyses) guidelines for Systematic Reviews and meta-analysis (Shamseer et al., 2015).

2.1. Data sources and searches

We searched the following electronic databases (from inception to June 2016): MEDLINE (accessed by PubMed), Physiotherapy Evidence Database (PEDro), The Cochrane Central Register of Controlled Trials (Cochrane CENTRAL), and *Centro Latino-Americano e do Caribe de Informação em Ciências da Saúde* (LILACS). In addition, we searched the references of published studies. The search comprised the following terms: "Flexibility", "Range of Motion", "Joint Range of Motion", "Joint Flexibility", "Muscle Strength", "Strength, muscle", "Muscle Strength Dynamometer", "Performance, Athletic", "Static Stretching", "PNF stretching", "Muscle Stretching Exercises" combined with a high sensitivity combination of words used in the search for randomized clinical trials (Robinson & Dickersin, 2002). We included publications in English, Spanish, and Portuguese. For the combination of the keywords, we utilized the Boolean terms AND and OR. The complete search strategy used for the MEDLINE database is shown in Appendix A.

2.2. Eligibility criteria

We included randomized clinical trials (RCT), controlled clinical trials (CCT), single group, and nonrandomized studies. We opted for including all types of studies since high-quality articles are scarce in the matter investigated in the present review. We included studies that evaluated the long-term effects of stretching on MP. We included studies that employed the three most common stretching techniques: (1) Dynamic stretching, which involves the execution of movement patterns throughout the available range of motion (ROM) (Costa et al., 2014); (2) Static stretching (SS), which involves reaching a certain ROM and holding the muscle (group) lengthened for a predetermined period of time (Bandy & Irion, 1994); and (3) Proprioceptive neuromuscular facilitation (PNF) stretching, which uses SS and isometric contractions of the target muscle in a cyclical pattern (Sharman, Cresswell, & Riek, 2006). Muscle performance could have been evaluated by functional tests that follow the stretch-shortening cycle (SSC) principle, isokinetic dynamometry (isotonic or isometric contraction), or repetition-maximum (RM) testing. The following exclusion criteria were used: (1) samples comprised of people with any disease/dysfunction; (2) FT shorter than three weeks or 12 sessions; (3) samples with mean age under 18 or over 40 years old; (4) non-application of muscle stretching; (5) no assessment of MP.

2.3. Studies selection and data extraction

Two investigators independently evaluated titles and abstracts of all articles identified by the search strategy. All abstracts that did not provide sufficient information regarding the inclusion and exclusion criteria were selected for full-text evaluation. In the second phase, the same reviewers independently evaluated the full-text articles and made their selection in accordance with the eligibility criteria. Disagreements between reviewers were solved by consensus or through a third person review. Using standardized forms, the same two reviewers independently conducted data extraction with regard to the methodological characteristics of the studies, number of participants, age, interventions, muscle group evaluated, assessment protocol, and conclusions. Disagreements were also solved by consensus. The main outcome extracted was MP.

2.4. Quality assessment

Study quality assessment included adequate sequence generation, allocation concealment, blinding of outcome assessors, description of losses and exclusions, and intention-to-treat analysis. Use of intention-to-treat analysis was considered as a confirmation on study assessment that the number of participants randomized and the number analyzed were identical, except for patients lost to follow-up or who withdrew consent for study participation. Studies without a clear description of these characteristics were considered as unclear or not reporting the latter. The same two reviewers independently performed the quality assessment.