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Effects of stretching during warm-up on motor performance: a protocol for systematic reviews and meta-analysis

Efectos de los estiramientos durante el calentamiento en el rendimiento motor: un protocolo para revisiones sistemáticas y meta-análisis

Rubén Fernández-Agulló[1]

[1]Universidad de Málaga, Málaga, España

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Correspondencia del autor: Rubén Fernández Agulló, ruben_9039@uma.es

Abstract

Before starting any physical activity, it is common to warm-up. However, the effects of including stretching in the warm-up remain controversial, and so does the most appropriate type of stretching depending on the activity to be performed afterwards. Thus, the aim of this article is to establish a systematic review protocol to analyze the effects of including different types of stretching in the warm-up on motor performance. The different basic physical abilities (strength, endurance, speed, flexibility) and coordinative abilities (coordination, balance, agility) will be analyzed. To this end, a systematic review will be carried out by examining eight electronic databases (Web of Science™ (all databases), Scopus, SPORTDiscus with Full Text, Pub-Med, CINAHL, Cochrane Library Plus, ProQuest Dissertations & Theses Global™ and WorldCat), along with carrying out a complementary search phase (snowballing). This will be followed by a meta-analysis, where each selected study will be coded (study characteristics, participant characteristics, intervention characteristics, intervention outcomes) using an ad hoc code established by the research group and previously tested on a sample of studies at the beginning of the review. To ensure the methodological quality of the systematic review, as well as its accuracy and transparency, the PRISMA-P and Cochrane Handbook protocol for systematic reviews will be employed.

Key words: PRISMA-P, Cochrane Handbook, Basic Physical Abilities, Coordinative Abilities

Resumen

Antes de comenzar cualquier actividad física es común realizar un calentamiento. Sin embargo, aún existe controversia sobre los efectos de incluir estiramientos, así como el tipo de estiramientos más indicados según la actividad que vaya a practicarse posteriormente. El objetivo del artículo es establecer un protocolo de revisión sistemática para analizar los efectos de la inclusión de distintas técnicas de estiramiento durante el calentamiento en el rendimiento físico. Se analizarán las diferentes cualidades físicas básicas (fuerza, resistencia, velocidad, flexibilidad) y coordinativas (coordinación, equilibrio, agilidad). Para ello se hará una revisión

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sistemática analizando ocho bases de datos electrónicas (Web of Science™ (all databases), Scopus, SPORTDiscus with Full Text, Pub-Med, CINAHL, Cochrane Library Plus, ProQuest Dissertations & Theses Global™ y WorldCat), además de realizar una fase de búsqueda complementaria (snowballing). Tras esto se realizará un meta-análisis, donde cada estudio seleccionado se codificará (características del estudio, características de los participantes, características de la intervención, resultados de la intervención) usando un código ad hoc establecido por el grupo de investigación y probado anteriormente en una muestra de estudios al principio de la revisión. Para asegurar la calidad metodológica de la revisión sistemática, así como su precisión y transparencia, se va a seguir el protocolo PRISMA-P y Cochrane Handbook para revisiones sistemáticas.

Palabras claves: PRISMA-P, Cochrane Handbook, Cualidades Físicas Básicas, Cualidades Coordinativas

INTRODUCTION

Warm-up is the most common practice at the beginning of any training or sport event (Gómez-Álvarez et al., 2021; Kar & Banerjee, 2013). It is defined as a physical activity performed in preparation for training, competition or physical assessment. It traditionally consists of low to moderate intensity aerobic activity, stretching and specific exercises (Chang et al., 2020). Traditionally, benefits such as increased body temperature, blood flow, coordination or body temperature have been attributed to warm-up (Bishop & Middleton, 2013; Singh & Singh, 2015). It is also noted that warming up seems to have a positive effect on performance and injury reduction (Chaouachi et al., 2010; Gelen, 2011). For all these reasons, its practice is recommended before any training or Physical Education session (Fernández-Agulló & Merino-Marban, 2022).

In recent years, there has been an increased interest in the effects of warm-up on sports performance, leading to an increase in the number of studies on this topic (Álvarez-Fernández et al., 2021; Ayala et al., 2011). However, there appear to be no systematic reviews that test the effects of including stretching in the warm-up to the date. I consider the study of this topic crucial with a view to offer a proper guidance to anyone willing to optimize the motor performance. For this reason, the aim of this systematic review protocol is to provide a guideline for testing the effects of the inclusion of stretching in the warm-up on motor performance, following PRISMA-P and Cochrane Handbook protocol for systematic reviews.

Stretching could be defined as “movement applied by an external and/or internal force in order to increase muscle flexibility and/or joint range of motion” (Weerapong et al., 2004, p. 190). Usually, benefits like enhance performance and decrease the risk of injury has been assigned to these exercises (Gerdijan et al., 2021; Gleim & Mchugh, 1997).

In that way, there is a majority opinion in literature (Simic et al., 2013) that defend the inclusion of static stretching, or no stretching, reduces performance in explosive strength activities, such as vertical jumps, horizontal jumps or sprinting, while dynamic stretching produces a clear improvement (Faigenbaum et al., 2010; Needham et al., 2009; Thompsen et al., 2007; Zmijewski et al., 2020). The same conclusion has been verified in other research focusing on school-age students (Duncan & Woodfield, 2006; Faigenbaum et al., 2005; Gelen, 2011; Merino-Marban et al., 2021).

In the other way, some previous studies have argued that prolonged static stretching have no effect on the countermovement jump test in girl gymnasts (Papia et al., 2018), as well as that static stretching has no negative effect on the vertical jump in adolescent tennis players

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(Carvalho et al., 2009). Furthermore, no differences have been found between static and dynamic stretching on vertical jump in female volleyball players (Dalrymple et al., 2010). However, some studies suggest that dynamic stretching, as well as static stretching, may be counterproductive prior to explosive strength training (Paradisis et al., 2013).

As can be seen, the impact of the inclusion of stretching in the warm-up is still unclear. So, a systematic review is needed to provide us an updated perspective of this topic.

To reach this objective, PRISMA-P (Shamseer et al., 2015) it is going to be used as a tool to assess the methodological quality of the systematic review and ensure that all its aspects will be accurately and transparently reported (Sarkis-Onofre et al., 2021).

MATERIAL AND METHODS

The review protocol has been sent to be registered with the International Prospective Register for Systematic Reviews. The systematic review and meta-analysis will be based on the methodology described in previous reference literature such as the PRISMA guidelines (Page et al., 2021) and Cochrane Handbook for Systematic Reviews of Interventions (Higgins, 2021), among other important references (Cooper et al., 2019; Borenstein et al., 2009). Firstly, a reproducible, transparent, and comprehensive systematic review will be performed to identify, select, and synthesize all the relevant studies. Then, a meta-analysis would be performed to provide more precise estimates of the effects than those derived from the primary studies.

Eligibility Criteria

The eligibility criteria for including the retrieved studies in the systematic review will be the following: (1) participants: apparently healthy humans (i.e., populations with diagnosed diseases/conditions will be excluded) with no age restriction; (2) intervention: studies that examine the effects of stretching in the warm-up, alone or as a part of the warm-up (methods or techniques through mobilization, massage, relaxation, tape, or devices such as balls, rollers, foam rollers, percussion pistols, etc., are excluded); (3) comparator: studies should include control or traditional condition/group (i.e., do the same warm-up, but without the stretching or no warm-up at all) or other experimental condition or another type of stretching (exercise, technique, etc.); (4) outcome: studies that evaluate the effect of stretching inclusion in the warm-up in the basic physical abilities or coordinative abilities through validated and objective tests; (5) study design: randomized controlled crossover, cluster randomized controlled crossover, randomized controlled trial or cluster randomized controlled trial.

Data Sources and Search Strategy

The databases search will include the following eight electronic bibliographic databases: Web of Science™ (all databases), Scopus, SPORTDiscus with Full Text, Pub-Med, CINAHL, Cochrane Library Plus, ProQuest Dissertations & Theses Global™ and WorldCat. The searches will be carried out in the search field type “title, abstract, and keywords” or equivalent. The search terms used will be based on two concepts: (1) warm-up, and (2) stretching. The terms of the same concept will be combined with the Boolean operator “OR” and then the two concepts will be combined using the Boolean operator “AND.” The keywords with more than one word will be enclosed in quotes. No publication status, language, or date restrictions will be imposed (Cooper et al., 2019). In case that research in question is not achieved with full text, authors will be contacted via email.

Then, additional studies will be identified as follows (i.e., “snowballing”): (1) searching the reference lists of original studies, as well as some related study reviews and study protocols; (2) examining the reference citations and the researchers’ publications (first authors) in the Web

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of Science™ and Scopus databases; (3) contacting with the corresponding authors by email, and (4) screening the researchers' personal lists in ResearchGate and Google Scholar (first authors). Anytime a new study is found, all these modes of searching will be repeated until no new study appeared.

Study Selection

After eliminating duplicates, the first author (RFA) will undertake the potentially eligible records selection based on the screening of titles and abstracts to identify relevant studies. After that, two independent reviewers will assess the full texts for inclusion following the above-mentioned eligibility criteria (RFA/RMM). Any disagreements regarding the inclusion of studies will be resolved by consensus with a third reviewer (DMV).

Data Extraction

From each selected study, data will be code using an ad hoc coding form developed by the research group (RFA/DMV) and previously tested with a pilot sample of studies at the beginning of the review. This form included data about: (1) study characteristics (i.e., reference, publication date, date of the data collection, study design, sequence generation, suspicion of selective outcomes, and initial and final sample size); (2) participant characteristics (i.e., sex and age); (3) intervention characteristics (intervention length, type of stretching, duration of stretching, series of stretching, intensity of stretching, muscles stretched, stretching position…); and (4) results of the intervention for each group (i.e., initial and final group size, pre- and post-intervention standard deviation, and pre- and post-intervention means score or pre–post-intervention mean difference score).

If a study consisted of two or more study arms of which one of the intervention arms did not meet the inclusion criteria, data will only be extracted from the study arms that meet the inclusion criteria. In the event that the studies did not report some study feature, corresponding authors will be contacted to retrieve it. If means and standard deviation would not retrieve, the scores will be estimated and converted by the standard error, confidence intervals, F, t or p values (Higgins et al., 2021). Since median and inter-quartile range are often used when the data are asymmetrical, these values will not be converted (Higgins et al., 2021). If any other study feature will not retrieve, the information will be omitted. The sample size of each group, the mean scores of the pre- and/or post-intervention or mean difference scores of each group, and the measurement score of the dependent variable/s will be considered critical for including the selected studies from the systematic review in the meta-analysis. In order to avoid removing studies from the meta-analysis, numerical data will be extracted from their figures using the WebPlotDigitizer software (Higgins et al., 2021). Coding studies will be carried out independently by two researchers (RFA/DMV). When doubt or disagreement will occurre, a consensus will be always achieved through discussion.

Risk of Bias and Certainty of the Evidence

Based on the Cochrane risk-of-bias tool version 2 (Higgins et al., 2021), the following methodological domains will be assessed: (1) risk of bias arising from the randomization process; (2) risk of bias due to missing outcome data; (3) risk of bias in measurement of the outcomes, and (4) risk of bias in the selection of the reported results. Additionally, the overall certainty of the evidence will be rated as "high", "moderate", "low", or "very low" using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach (Guyatt et al., 2011). This assessment will be based on the following five domains: risk of bias, inconsistency, imprecision, indirectness, and publication bias. A domain will be classified as

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"no limitation" if no reason for downgrading the evidence is found, but the domain will be classified as "serious" if a reason is found for downgrading the evidence (thus, downgrading the certainty rating by one level). The reasons for considering the domains as "serious" will be: (a) risk of bias; (b) inconsistency; (c) imprecision; (d) indirectness; and (e) publication bias.

Data Analyses

The meta-analyses will be performed using the software Comprehensive Meta-Analysis version 3.3.070 for Windows (Biostat, Englewood, USA). This software allows multiple data entry formats according to each study design. Therefore, considering the data provided by each study, the input method that best suited each study will be chosen. Specifically, the option "one group with pre- and post-data" will be used for pre-experimental trials, while the options "unmatched groups with pre- and post-data in each group", "unmatched groups, mean change in each group", or "unmatched groups, post-data only in each group" will be used for controlled trials. The significance level will be set at $p < 0.05$. If a single study reported data for the whole sample and separately by different subsamples (e.g., children and adolescents), only the whole sample will be used. Moreover, when in the same study there will be different options for the same outcome (e.g., type of stretch) only the best option will be selected. When a study had more than one type of stretch intervention group, each group will be included in the analysis individually. The studies carried out with a small sample (defined as less than 10 participants per group) will not be included in the meta-analysis (Mayorga-Vega et al., 2016).

Effects Sizes Computation

A detailed description of the data analyses that will be carried out can be found elsewhere (Borenstein et al., 2019). Meta-analyses of the Cohen's d standardized mean difference and 95% confidence interval with a random-effects model will be conducted to obtain the intervention program effects.

Publication Bias

Firstly, an exhaustive systematic review will be carried out to avoid availability bias. Afterward, a deep examination of the selected studies will be made to avoid any potential duplication of the information retrieved. Similarities between publications of the same authors, with the same values and/or the same sample size will be examined. When the selected publications have full or partial duplicated information, these particular values will not be analyzed. Then, to visually identify the impact of any potential publication bias, the funnel plots and the Egger's test (Egger et al., 1997) will be carried out. Moreover, for assessing the impact of any potential publication bias, the Orwin's fail-safe N analyses (Orwin, 1983) (criterion for a "trivial" d= 0.10; mean d in missing studies, d= 0.00) (Cohen, 1992), the Duval and Tweedie's Trim and Fill method (Duval & Tweedie, 2000) (assuming missing studies in the left of the mean), and a cumulative meta-analysis sorted by larger study size will be computed (Borenstein et al., 2009).

Heterogeneity and Subgroups Analyses

The presence of statistical heterogeneity in the estimation of the effect sizes of the program will be examined with the I2 statistic. The thresholds for its interpretation will be: Values up to 40% will be considered not important, up to 75% moderate, and more than 75% high heterogeneity (Higgins et al, 2021). Based on a priori hypothesized moderators, sub-groups analyses will also be carried out to test the effect of the intervention regarding: (a) individuals' characteristics; and (b) intervention program characteristics. All subgroups'

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analyses will be carried out for between-study meta-analysis, while for within-study meta-analysis, only those with at least two units of analysis to compare with will be performed. Finally, the influence of continuous covariates on the intervention effect will also be evaluated using meta-regression analyses.

Sensitivity Analysis

Finally, in order to evaluate the robustness of the main results, the following sensitivity analyses will be performed: Cohen's d with a fixed-effect model, Hedges' g with a random-effects model, and Cohen's d with a random-effects model separately for randomized controlled trial design or not. Sensitivity analyses separately for studies classified by the overall risk of bias is pretended to be carried out.

DISCUSSION

Considering all the above, it is important to write a protocol to allow authors to lead a more transparent, complete, and accurate reporting of systematic reviews. Besides, it enables readers to assess the appropriateness of the methods, and the trustworthiness of the findings (Page et al., 2021).

The purpose of this particular protocol is to establish a guidance for the analysis of the impact of different types of stretching on motor performance. Furthermore, differences between types of stretching according to the basic physical abilities (strength, endurance, speed, flexibility) and coordinative abilities (coordination, balance, agility) will be studied. Moreover, in the systematic review we plan to check out if the components of the stretching exercises (intensity, volume, muscles stretched, number of exercises…) have any influence on motor performance.

Apart from that, future conclusions will be useful to help and guide trainers and PE teachers´ actions to develop better sessions and achieve the best results.

Finally, I hope this paper can be useful to authors as a guidance for systematic reviews and meta-analysis with a similar purpose.

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