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Effects of Neuromuscular Electrical Stimulation on Muscle Architecture: A systematic review with meta-analyses

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ADMINISTRATIVE INFORMATION

Support - None.

Review Stage at time of this submission - Formal screening of search results against eligibility criteria.

Conflicts of interest - The authors declare that they have no conflict of interest. However, this project will be conducted during a master class module by MSc students. The first 6 authors (MSc students) will be considered the first authors and will have a sign on their names showing that they equally contributed. The last two authors will be considered as equal supervisors with equal contributions.

INPLASY registration number: INPLASY2023120019

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 04 December 2023 and was last updated on 04 December 2023.

INTRODUCTION

Review question / Objective The following review question is employed in this review: What are the effects of the NMES on the architectural parameters of the human skeletal muscles based on randomized controlled trials?

Rationale Architectural parameters of human skeletal muscles are related to the rate of force development, physical performance and orthopaedical injuries. Therefore, there has been a growing interest in research on muscle architecture in the literature within the last decades. Neuromuscular electrical stimulation (NMES) is one of the physical therapy applications that aims to recover, preserve and improve muscle functionality by providing intermittent stimuli series to superficial skeletal muscles for facilitating activation of intramuscular nerve branches to generate visible muscle contractions. Therefore, reviewing the effects of the NMES on the architectural parameters of skeletal human muscles is warranted.

Condition being studied Effects of the NMES on human skeletal muscle architecture.

METHODS

Search strategy PubMed (1172 articles), ProQuest databases (753 articles) and OpenGrey database (383 articles) were searched on the 1st of December 2023 via using the following key terms: NMES OR “Electrical Stimulation” OR “Electric Stimulation” OR Electrotherapy OR Electrostimulation for the intervention key term groups and ACSA OR Architectur* OR “Cross

Sectional Area" OR "Cross-sectional Area" OR Fascic* OR "Fiber Length" OR "Fibre Length" OR Pennat* OR Pinnat* OR "Muscle Thickness" OR "Muscle Volume" OR "Muscle Structure" OR "Muscle Length" OR PCSA for the outcome key term group. Initially, 2308 citations were retrieved through database searches. 530 duplicate records were detected and removed among the citations retrieved from the PubMed and ProQuest databases using EndNote X21 software. The remaining 1395 records were imported into Rayyan software (Rayyan.ai a web and mobile app for systematic reviews) for being independently reviewed by the eight authors in a blind on status based on titles and abstracts. The citations in the OpenGrey database will be screened by the same authors in the blinded status on its webpage due to its technical limitations in exporting citations from this database. Additionally, reference lists of included studies will be screened in the same settings.

Participant or population Studies were conducted on humans will be selected.

Intervention Neuromuscular electrical stimulation.

Comparator Control/placebo groups.

Study designs to be included Randomized controlled trials (RCT).

Eligibility criteria Inclusion criteria are considered as: a) Being an RCT including a control or placebo group b) Using NMES as an intervention, and c) having a muscle architectural parameter as an outcome d) being conducted on human participants.

Information sources PubMed, ProQuest, OpenGrey, and reference lists of included studies.

Main outcome(s) Architectural parameters of human skeletal muscles.

Data management Data will be independently extracted by the authors in a blinded manner. The EndNote X21, Microsoft Excel and Word RevMan, and GRADEPro GDT software will be used during data extraction and analysis.

Quality assessment / Risk of bias analysis Cochrane Collaboration's risk of bias tool assessment tool for parallel group RCTs will be used to assess individual risk of bias assessment of each included study. In the case of quantitative data synthesis, the overall evidence level will be graded using the GRADE approach (Grading of Recommendations Assessment, Development and Evaluation).

Strategy of data synthesis The Review Manager (RevMan) of the Cochrane Collaboration or the Comprehensive Meta-analysis software will be utilized for conducting the meta-analyses. The GRADEpro GDT software will be used to determine the level of the body of evidence.

Subgroup analysis Subgroup analyses will be conducted based on intervention style, population or across the risk of bias tables.

Sensitivity analysis If there is a high heterogeneity between the studies in a meta-analysis, a sensitivity analysis will be performed based on methodological features and risk of bias assessments.

Language restriction English.

Country(ies) involved Republic of Turkey. The United Kingdom, The United States of America.

Keywords NMES, electrical stimulation, muscle architecture, fascicle length, muscle size, muscle thickness, pennation angle, cross-sectional area.

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