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Association of ultrasound parameters with muscle strength and sarcopenia-related exercise performance: A meta-analysis

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ADMINISTRATIVE INFORMATION

Support - None.

Review Stage at time of this submission - Preliminary searches.

Conflicts of interest - None declared.

INPLASY registration number: INPLASY202410086

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 19 January 2024 and was last updated on 19 January 2024.

INTRODUCTION

Review question / Objective The study aims to utilize meta-analysis to integrate data from various studies, comprehensively examine the associations between ultrasound parameters, muscle strength, and sarcopenia-related exercise performance in older adults. By further exploring the reliability of ultrasound in assessing muscle health and predicting functional outcomes in older individuals, this research seeks to provide insights for optimizing the care and well-being of older adults affected by sarcopenia.

Rationale Structural parameters obtained through ultrasound may be associated with muscle strength and functional performance in older adults. However, the meta-analysis approach provides a more reliable understanding by quantifying and consolidating these associations.

Condition being studied An increasing number of reviews are investigating the utility of ultrasound (US) in assessing age-related muscle loss. This study aimed to comprehensively explore the association between ultrasound parameters, muscle strength, and sarcopenia-related exercise performance in older adults using meta-analysis to integrate data from various studies.

METHODS

Search strategy PubMed, Web of Science, and Embase
((#1 AND #2 AND #3 AND #4 AND #5 AND) NOT ('disease OR 'patients')) limited to 'Humans' & 'English'
#1 Aged "Elderly OR "Old" OR "age" OR "old age" OR "older adult*" OR "older people" OR elder* OR "aging adults" OR "older person*" OR "old-age" OR Older OR "elderly person*" OR Aging OR Ageing OR Aged OR "old man" OR "old men" OR "old women" OR "old woman"
#2 Ultrasonography "Ultrasound Imaging" OR "Ultrasound Parameters" OR "Echo intensity" OR "EI" OR "echo" "OR "muscle thickness" OR "MT" OR "fascicle length" "FL" OR "PA" OR "pennation angle" OR "cross-sectional area" OR "CSA"

#3 Thigh Thighs OR “Quadriceps Muscle” OR “Quadriceps Muscles” OR “Quadriceps Femoris” OR “Vastus Medialis” OR “Vastus Intermedius” OR “Rectus Femoris” OR “Vastus Lateralis” OR “knee extensors” OR Knee OR “Hamstring Muscles” OR “Hamstring Muscle” OR “Biceps Femoris” OR “Semimembranosus” OR “knee flexors”
#4 Muscle Strength Physical Functional Performance Muscle Strength OR “Physical Functional Performance” OR “Muscle Strength Dynamometer” OR Strength OR “maximal voluntary contraction” OR “Maximal voluntary isometric contraction” OR Power OR Force OR Torque OR MVC OR MVIC OR “explosive force” OR “explosive strength” OR “explosive torque” OR “Rate force development” OR RFD OR RTD OR “knee extensor*” OR “knee flexor*” OR “ankle dorsiflexor*” OR “ankle plantar flex* OR “Muscle Strength*” OR “sarcopenia-related exercise performance” OR “sarcopenia” OR “muscle atroph*” OR “muscular atroph”*OR “Physical Functional Performance” OR “Physical Functional Performance*” OR “Physical Performance*” OR “Functional Performance*” OR “Physical Function*” OR “muscle function” OR “neuromuscular function” OR “Hand Strength” OR “Hand Grip Strength” OR “grip strength OR Grip*” OR HGS OR “Gait Analysis” OR Gait OR Gaits OR “Gait Speed*” OR “Walking Speed*” OR “Walking Pace*” OR TUG OR “Walk Test OR walk*” OR “chair stand time” OR “sit-to-stand” OR “chair stand” OR “chair stand test” OR CST OR stand*
#5 Correlation “Correlate*” OR “Associat*” OR “Relat*”
Muscle Strength.

Participant or population (a) Participants were healthy community residents aged 60 years or older without major neurological and musculoskeletal disorders (b) Muscle mass testing using EI and reporting at least one direct assessment of muscle strength or physical function performance (c) Observational studies, including cross-sectional studies, cohort studies, and few case-control (d) Published studies (English)Articles were excluded if: (a) The participant was currently on medication or had an injury that limited physical activity and independence in daily living (b) The study was conducted in an animal model (c) Received interventions other than usual care or placebo and studies used RCTs experiment (d) The result is partially unable to extract the correlation coefficient (e) Reviews, abstracts, case reports or duplicate published articles (f) Non-english articles.

Intervention None.

Comparator Correlation R.

Study designs to be included The data extraction process involved coding for author information, year of publication, and population characteristics (sample size, sex, and mean age). The correlation coefficient r or standardized beta coefficient between Ultrasound Parameters and two continuous muscle strength or physical function variables were extracted. The test modality/results in the assessment of muscle strength and Sarcopenia-related exercise performance were also coded. Muscle strength was categorized into lower extremity maximum strength (i.e., maximal voluntary force/torque of the force-/torque-time curve [MVC]).

Eligibility criteria (a) Participants were healthy community residents aged 60 years or older without major neurological and musculoskeletal disorders (b) Muscle mass testing using ultrasound and reporting at least one direct assessment of muscle strength or Sarcopenia-related exercise performance (c) Observational studies, including cross-sectional studies, cohort studies, and few case-control (d) Published studies (English)Articles were excluded if: (a) The participant was currently on medication or had an injury that limited physical activity and independence in daily living (b) The study was conducted in an animal model (c) Received interventions other than usual care or placebo and studies used RCTs experiment (d) The result is partially unable to extract the correlation coefficient (e) Reviews, abstracts, case reports or duplicate published articles (f) Non-English articles.

Information sources PubMed, Web of Science, and Embase.

Main outcome(s) The meta-analysis was conducted using Comprehensive Meta-Analysis (CMA) software, version 3.3.070, to analyze the Pearson Product Moment correlation coefficients (R-value) obtained from the included studies. The R-values were converted into normally distributed variables (z-transformed Rz-value) using Fisher's z transformation.[16] The conversion formula is: $z' = 0.5[\ln(1+r) - \ln(1-r)]$ where ln is the natural logarithm. The beta coefficient (β) is converted to a value of r using the following formula.[17] $r = 0.98\beta + 0.05\lambda$, (if $\beta \geq 0$, $\lambda = 1$; $\beta < 0$, $\lambda = 0$). The weights of the study were calculated based on the standard errors (SE). The calculation formula is: SE = 1 /
(where n is the sample size. A random-effects model was selected for the meta-analysis. Correlations (positive or negative) were classified as small (r 0.5)[18] Forest plots were used to

display studies with 95% confidence intervals and the combined coefficients. The r z values were reverse converted to r values to classify and interpret the relevant sizes. The heterogeneity of the results between studies was evaluated using the I 2 index, where I2 ≤ 25% was considered to indicate low heterogeneity, 25% < I2 < 75% was considered to indicate moderate heterogeneity, and I2 ≥ 75% was considered to indicate high heterogeneity[19] Finally, to address the possibility of publication bias, we examined funnel plots and used Begg and Mazumdar rank correlations. The Trim and Fill procedure [20] was applied if evidence of publication bias was noted.

Data management ENDNOTE ; Comprehensive Meta-Analysis (CMA).

Quality assessment / Risk of bias analysis The Joanna Briggs Institute (JBI).

Strategy of data synthesis The R-values were converted into normally distributed variables (z-transformed Rz-value) using Fisher's z transformation.[16] The conversion formula is:z' = 0.5[ln(1+r) - ln(1-r)] where ln is the natural logarithm.The beta coefficient (β) is converted to a value of r using the following formula.r = 0.98β + 0.05λ, (if (β ≥ 0, λ = 1; β < 0, λ = 0).The weights of the study were calculated based on the standard errors (SE). A random-effects model was selected for the meta-analysis.

Subgroup analysis None.

Sensitivity analysis funnel chart; Cut and fill method.

Language restriction only English.

Country(ies) involved China/South Korea.

Keywords Ultrasonography, Sarcopenia, Muscle Strength, Physical Functional Performance, Aging.

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