

## **Total training volume for the treatment of shoulder impingement syndrome: a systematic review protocol with meta-analysis**

**Volume total de treinamento para o tratamento da síndrome do impacto do ombro: um protocolo de revisão sistemática com metanálise**

**Volumen total de entrenamiento para el tratamiento del síndrome de pinzamiento del hombro: un protocolo de revisión sistemática con metanálises**

Received: 06/06/2023 | Revised: 06/15/2023 | Accepted: 06/16/2023 | Published: 06/20/2023

**Paulo Rodrigo Santos Aristides**

ORCID: <https://orcid.org/0000-0003-1247-9752>  
Bahiana School of Medicine and Public Health, Brazil

E-mail: [rodrigoaristides.pos@bahiana.edu.br](mailto:rodrigoaristides.pos@bahiana.edu.br)

**Ana Lúcia Barbosa Góes**

ORCID: <https://orcid.org/0000-0003-2486-0876>  
Bahiana School of Medicine and Public Health, Brazil

E-mail: [albgoes@bahiana.edu.br](mailto:albgoes@bahiana.edu.br)

**Kátia Nunes Sá**

ORCID: <https://orcid.org/0000-0002-0255-4379>  
Bahiana School of Medicine and Public Health, Brazil

E-mail: [katia.sa@bahiana.edu.br](mailto:katia.sa@bahiana.edu.br)

### **Abstract**

This systematic review protocol with meta-analysis aims to verify the effects of the total volume of resistance training on pain outcomes and functional capacity in individuals with Shoulder Impingement Syndrome. This review will be developed following the steps of formulation of the research question, search for randomized clinical trials, selection of studies considering the eligibility criteria, data extraction, analysis and synthesis of evidence. The question will be based on PICOS strategy: “What total volumes of resistance training reduce pain and improve function in individuals with shoulder impingement syndrome?” Searches will be carried out in 12 databases and gray literature sources. The results will be exported to the Rayyan application so that two independent and blind reviewers can perform the exclusion of duplicates and selection of studies by reading titles and abstracts. Randomized clinical trials that analyzed the effects of resistance training in the treatment of shoulder impingement syndrome will be selected for full-text reading, of which, studies that meet the eligibility criteria will have their data extracted and submitted to narrative synthesis and, if possible, to the meta-analysis. The Physiotherapy Evidence Database (PEDro) tools will be used to analyze the methodological quality and the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) for the quality of the evidence.

**Keywords:** Shoulder impingement syndrome; Shoulder pain; Rehabilitation; Exercise; Resistance training.

### **Resumo**

Este protocolo de revisão sistemática com metanálise visa verificar os efeitos do volume total de treinamento resistido sobre os desfechos de dor e capacidade funcional em indivíduos com Síndrome do Impacto do Ombro. Esta revisão será desenvolvida seguindo as etapas de formulação da pergunta de pesquisa, busca de ensaios clínicos randomizados, seleção dos estudos considerando os critérios de elegibilidade, extração dos dados, análise e síntese das evidências. A pergunta será baseada na estratégia PICOS: “Quais volumes totais de treinamento resistido reduzem a dor e melhoram a função em indivíduos com síndrome do impacto do ombro?” Serão realizadas buscas em 12 bases de dados e em fontes de literatura cinza. Os resultados serão exportados para o aplicativo Rayyan para que dois revisores independentes e de forma cega possam realizar a exclusão das duplicatas e a seleção dos estudos por meio da leitura de títulos e resumos. Ensaios clínicos randomizados que analisaram os efeitos do treinamento resistido no tratamento da síndrome do impacto do ombro serão selecionados para leitura de texto completo, dos quais, os estudos que atenderem os critérios de elegibilidade terão seus dados extraídos e submetidos à síntese narrativa e, se possível, à metanálise. Serão utilizadas as ferramentas Physiotherapy Evidence Database (PEDro) para análise da qualidade metodológica e Grading of Recommendations Assessment, Development, and Evaluation (GRADE) para a qualidade da evidência.

**Palavras-chave:** Síndrome do impacto do ombro; Dor no ombro; Reabilitação; Exercício físico; Treinamento de força.

## Resumen

Este protocolo de revisión sistemática con metanálisis tiene como objetivo verificar los efectos del volumen total de entrenamiento de fuerza sobre los resultados del dolor y la capacidad funcional en personas con síndrome de pinzamiento del hombro. Esta revisión se desarrollará siguiendo las etapas de formulación de la pregunta de investigación, búsqueda de ensayos clínicos aleatorizados, selección de estudios considerando los criterios de elegibilidad, extracción de datos, análisis y síntesis de evidencia. La pregunta se basará en la estrategia PICOS: "¿Qué volúmenes totales de entrenamiento de resistencia reducen el dolor y mejoran la función en personas con síndrome de pinzamiento del hombro?" Las búsquedas se realizarán en 12 bases de datos y fuentes de literatura gris. Los resultados se exportarán a la aplicación Rayyan para que dos revisores independientes y ciegos puedan realizar la exclusión de duplicados y la selección de estudios mediante la lectura de títulos y resúmenes. Los ensayos clínicos aleatorizados que analizaron los efectos del entrenamiento de fuerza en el tratamiento del síndrome de pinzamiento del hombro se seleccionarán para la lectura de texto completo, de los cuales, los estudios que cumplan con los criterios de elegibilidad tendrán sus datos extraídos y sometidos a síntesis narrativa y, si es posible, al metanálisis. Se utilizarán las herramientas Physiotherapy Evidence Database (PEDro) para analizar la calidad metodológica y el Grading of Recommendations Assessment, Development, and Evaluation (GRADE) para la calidad de la evidencia.

**Palabras clave:** Síndrome de abducción dolorosa del hombro; Dolor de hombro; Rehabilitación; Ejercicio físico; Entrenamiento de fuerza.

## 1. Introduction

Shoulder complex is a group of articulations (glenohumeral, acromioclavicular, sternoclavicular and scapulothoracic) which form a mobile connection between the axial and appendicular skeletons, giving the individual the needed functionality for the performance of daily activities. However, these articulations and their structures daily receive functional demands that may trigger pathological conditions that are generically characterized as shoulder pain (Bakhsh & Nicandri, 2018).

Shoulder pain is among the most common musculoskeletal complaints, showing a predominance between 6,7 and 66,7% throughout life (Luime et al., 2004). In Brazil, a cross-sectional study showed a predominance of 24% for shoulder pain (Bento et al., 2019). Among the diagnoses in people with shoulder pain, there is the Subacromial Impingement Syndrome (Garving et al., 2017), a clinical condition in which it is observed the impairment of different structures that permeate the subacromial space, such as bursa, tendons and ligaments (Michener et al., 2004). The pain and the reduction of the shoulder functional capacity, which are secondary to the problems that affect the subacromial structures, can be disabling and limit daily, labor and self-care activities, beyond increasing the costs that are related to absenteeism and healthcare (Van der Windt et al., 1996; Harkness et al., 2003; Virta et al., 2012; Marks et al., 2019). Then, this condition demands that the health professionals who are involved in the musculoskeletal rehabilitation, develop strategies for more efficient intervention strategies and with lower costs.

The conservative approach (non-surgical) is the first option of intervention in most of the cases of subacromial pain syndrome, in which big structural damages are not observed (Kulkarni et al., 2015). Independently of the combination of the therapeutic resources that had been selected for this approach, the resisted exercise has been broadly recommended as a type of intervention (alone or grouped with other techniques) in the clinical practice (Ravichandran et al., 2020; Dominguez-Romero et al., 2021). However, available evidence shows varied results on the efficacy of interventions that are based on resisted exercises. These uncertainties and divergences can be related to great differences in the dosages that are used on intervention studies, as well as the lack of data on resisted training (Abdulla et al., 2015; Desmeules et al., 2016). The success of any program of resistance training depends on the rational manipulation of training variables, such as: amount of exercises, series, repetitions, load, speed in the execution of movements, rest and frequency intervals (Baker et al., 1994). Additionally, there is the challenge of monitoring the Total Training Volume that had been held, and in order so, there has been proposed different ways for quantification (McBride et al., 2009).

The most popular training method of quantification uses a formula which multiplies the number of series by the number of repetitions and load (in kilograms) implemented in all the exercises of a session (Schoenfeld et al., 2014). However,

this proposition represents an obstacle for the situations of clinical practice in musculoskeletal rehabilitation, in which there are implemented resistances of difficult quantification, such as the elastic ones. Under this perspective, there has been proposed alternatives for the control of the total training volume, not only for the investigations, but for the clinical practice in musculoskeletal approaches, as well.

Recently, a systematic review demonstrated that quantifying the total volume of training, taking into consideration only the total number of weekly series by muscular group, can be an interesting method to induce muscle mass gain, when a band of maximum repetition – between 6 and 20 – done until the concentric failure ( or near it) is guided (Baz-Valle et al., 2021). Additionally, there is a relation of dose-response with the number of weekly series of held resisted exercises and adaptations in the skeletal muscle (Schoenfeld et al., 2017).

The aim of this systematic review is to investigate the effects of different total volumes of resistant training (in weekly series) on the pain and the functional ability of individuals with subacromial pain syndrome. Preliminarily, we did a search in the International Prospective Register of Systematic Reviews (PROSPERO), and there were not found records that are similar to the aims of this review. Following, we registered a protocol of systematic review entitled “Total training volume for shoulder impingement syndrome treatment: a systematic review with meta-analysis”, under the code CRD42021261802.

## 2. Methodology

This protocol of systematic review was developed according to the recommendations of Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (Page et al., 2021).

The question in the research was “Which total resistance training volumes reduce the pain and increase the function in individuals with shoulder impingement syndrome”, and it was elaborated based in the acronym PICOS with the following definitions: Population (P), adults with shoulder pain related to the subacromial pain syndrome; Intervention (I), only with resisted exercises for periarticular and scapular muscles; Comparison (C) comparisons could be made with groups that received any other type of intervention, as for example, physical exercise ( including resisted, endurance and stretching), manual therapy, electrothermal phototherapy, acupuncture, medicalization, minimum/ usual cares, a combination of the former ones or the natural course of the disease; Outcomes (O) of interest are pain and role of the shoulder; Type of study (S) randomized clinical trials.

The eligible studies for this review will be selected based on the following criteria: randomized clinical trials with adult population ( $\geq 18$  years old), showing pain in the shoulder related to the subacromial pain syndrome, at least in one of the groups, shall exclusively present resisted exercises, description of variables of interest of resisted training (weekly frequency, number of exercises, series and repetitions), with an outcome of pain and shoulder function. There will not be included studies whose participants present pain in the shoulder that are related to cervical pathology, traumatic injuries, adhesive capsulitis, bone injuries, rheumatic disease, neurological dysfunctions and cancer. The search will be done based on PubMed data (Table 1), The Cochrane Central Register of Controlled Trials, Cinahl, Embase, Lilacs, Medline, Pedro, Scielo, Scopus, Web of Science, Sportdiscus, Google Scholar, beyond manual searches in the grey literature.

The search strategies will make use of the combination of key words and MeSH (Medical Subjective Headings), DeCS (Health Sciences Descriptors) terminology, with the Boolean operators OR and AND which are adapted to the parameters of each basis.

**Table 1** - Search strategy of articles that will be used in a database.

Database	Vocabulary
Pubmed	((((((((((((((((((((Shoulder Impingement Syndrome) OR (Rotator Cuff Impingement)) OR (Coracohumeral Impingement)) AND (Exercise)) OR (resistance training)) OR (Concentric exercise)) OR (Concentric training)) OR (Eccentric exercise)) OR (Eccentric training)) OR (Isometric exercise)) OR (Isometric training)) OR (Isotonic exercise)) OR (Isotonic training)) OR (Scapular focused exercise)) OR (scapular stabilization exercise)) AND (Shoulder pain)) AND (Shoulder Function)) OR (Shoulder functional capacity)) NOT (Electrotherapy)) NOT (Stretching)) NOT (scapular kinematics)) NOT (manipulative therapy)

Source: Created by the authors.

The found citations in the database will be exported to the software Rayyan from Qatar Computing Research Institute (Ouzzani et al., 2016). Two reviewers (PRSA and FNAS) will, independently and double blindly evaluate, and in case of disagreement, there will be some conversation to solve the issue. If the disagreement still persists, a third evaluator will be consulted. At first, duplicate titles and abstracts will be removed and, following, the studies will be analyzed according to eligibility criteria. The selected studies will be read in full, and their information will be or extracted or analyzed. The application Mendeley Reference Manager (Yamakawa et al., 2014) will be used as a reference handler.

The following information will be extracted and organized in a table: author, year, sample size, sex, age, inclusion criteria, intervention protocols (weekly frequency, duration, exercises, series, repetitions) and outcome measures (pain and function). It will be held the quantification of the total resisted training volume (in weekly series), in order to relate them to the outcomes of interest for the building of a narrative synthesis. If possible, a quantitative analysis will be held through meta-analysis. The methodological quality of included studies will be evaluated by using the Brazilian version of the tool Physiotherapy Evidence Database (PEDro) (Shiwa et al., 2011).

Ultimately, we will use GRADE (Grading of Recommendations Assessment, Development, and Evaluation) to analyze the articles and classify them according to the degree of certainty of evidence, into high, moderate, low or very low para (Guyatt et al., 2011).

### 3. Expected Results

It is aimed that this systematic review with meta-analysis, identifies randomized clinical trials with methodological quality and assurance evidence that subsidize the clinical decisions of professionals, in the areas of Physical Education and Physiotherapy, on the total resisted training volumes (in weekly series) which are more appropriate to improve the function of patients with shoulder impingement syndrome.

### 4. Funding and Conflict of Interests

This work will not count on any funding and all authors declare that they have no conflict of interest.

### References

Abdulla, S. Y., Southerst, D., Côté, P., Shearer, H. M., Sutton, D., Randhawa, K., Varatharajan, S., Wong, J. J., Yu, H., Marchand, A. A., Chrobak, K., Woitzik, E., Shergill, Y., Ferguson, B., Stupar, M., Nordin, M., Jacobs, C., Mior, S., Carroll, L. J., & Taylor-Vaisey, A. (2015). Is exercise effective for the management of subacromial impingement syndrome and other soft tissue injuries of the shoulder? A systematic review by the Ontario Protocol for Traffic Injury Management (OPTIMA) Collaboration. *Manual Therapy*, 20(5), 646–656. <https://doi.org/10.1016/j.math.2015.03.013>

Baker, D., Wilson, G., & Carlyon, R. (1994). Periodization. *Journal of Strength and Conditioning Research*, 8(4), 235–242. <https://doi.org/10.1519/00124278-199411000-00006>

- Bakhsh, W., & Nicandri, G. (2018). Anatomy and Physical Examination of the Shoulder. *Sports Medicine and Arthroscopy Review*, 26(3), e10–e22. <https://doi.org/10.1097/JSA.0000000000000202>
- Baz-Valle, E., Fontes-Villalba, M., & Santos-Concejero, J. (2021). Total Number of Sets as a Training Volume Quantification Method for Muscle Hypertrophy: A Systematic Review. *Journal of Strength and Conditioning Research*, 35(3), 870–878. <https://doi.org/10.1519/JSC.0000000000002776>
- Bento, T. P. F., Genebra, C. V. dos S., Cornélio, G. P., Biancon, R. D. B., Simeão, S. F. A. P., & Vitta, A. De. (2019). Prevalence and factors associated with shoulder pain in the general population: a cross-sectional study. *Fisioterapia e Pesquisa*, 26(4), 401–406. <https://doi.org/10.1590/1809-2950/18026626042019>
- Desmeules, F., Boudreault, J., Dionne, C. E., Frémont, P., Lowry, V., MacDermid, J. C., & Roy, J. S. (2016). Efficacy of exercise therapy in workers with rotator cuff tendinopathy: A systematic review. In *Journal of Occupational Health* 58(5), 389–403. <https://doi.org/10.1539/joh.15-0103-RA>
- Dominguez-Romero, J. G., Jiménez-Rejano, J. J., Rídao-Fernández, C., & Chamorro-Moriana, G. (2021). Exercise-Based Muscle Development Programmes and Their Effectiveness in the Functional Recovery of Rotator Cuff Tendinopathy: A Systematic Review. *Diagnostics*, 11(3), 529. <https://doi.org/10.3390/diagnostics11030529>
- Garving, C., Jakob, S., Bauer, I., Nadjar, R., & Brunner, U. H. (2017). Impingement Syndrome of the Shoulder. *Deutsches Ärzteblatt International*, 114(45), 765–776. <https://doi.org/10.3238/arztebl.2017.0765>
- Guyatt, G., Oxman, A. D., Akl, E. A., Kunz, R., Vist, G., Brozek, J., Norris, S., Falck-Ytter, Y., Glasziou, P., Debeer, H., Jaeschke, R., Rind, D., Meerpohl, J., Dahm, P., & Schünemann, H. J. (2011). GRADE guidelines: 1. Introduction - GRADE evidence profiles and summary of findings tables. *Journal of Clinical Epidemiology*, 64(4), 383–394. <https://doi.org/10.1016/j.jclinepi.2010.04.026>
- Harkness, E. F., Macfarlane, G. J., Nahit, E. S., Silman, A. J., & McBeth, J. (2003). Mechanical and psychosocial factors predict new onset shoulder pain: a prospective cohort study of newly employed workers. *Occupational and Environmental Medicine*, 60(11), 850–857. <https://doi.org/10.1136/oem.60.11.850>
- Kulkarni, R., Gibson, J., Brownson, P., Thomas, M., Rangan, A., Carr, A. J., & Rees, J. L. (2015). Subacromial shoulder pain. *Shoulder & Elbow*, 7(2), 135–143. <https://doi.org/10.1177/1758573215576456>
- Luime, J. J., Koes, B. W., Hendriksen, I. J. M., Burdorf, A., Verhagen, A. P., Miedema, H. S., & Verhaar, J. A. N. (2004). Prevalence and incidence of shoulder pain in the general population; a systematic review. *Scandinavian Journal of Rheumatology*, 33(2), 73–81. <https://doi.org/10.1080/03009740310004667>
- Marks, D., Comans, T., Bisset, L., Thomas, M., & Scuffham, P. A. (2019). Shoulder pain cost-of-illness in patients referred for public orthopaedic care in Australia. *Australian Health Review: A Publication of the Australian Hospital Association*, 43(5), 540–548. <https://doi.org/10.1071/AH17242>
- McBride, J. M., McCaulley, G. O., Cormie, P., Nuzzo, J. L., Cavill, M. J., & Triplett, N. T. (2009). Comparison of Methods to Quantify Volume During Resistance Exercise. *Journal of Strength and Conditioning Research*, 23(1), 106–110. <https://doi.org/10.1519/JSC.0b013e3181818efdf>
- Michener, L. A., Walsworth, M. K., & Burnet, E. N. (2004). Effectiveness of rehabilitation for patients with subacromial impingement syndrome: A systematic review. *Journal of Hand Therapy*, 17(2), 152–164. <https://doi.org/10.1197/j.jht.2004.02.004>
- Ouzzani, M., Hammady, H., Fedorowicz, Z., & Elmagarmid, A. (2016). Rayyan-a web and mobile app for systematic reviews. *Systematic Reviews*, 5(1). <https://doi.org/10.1186/s13643-016-0384-4>
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., & Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. In *The BMJ* (Vol. 372). BMJ Publishing Group. <https://doi.org/10.1136/bmj.n71>
- Ravichandran, H., Janakiraman, B., Gelaw, A. Y., Fisseha, B., Sundaram, S., & Sharma, H. R. (2020). Effect of scapular stabilization exercise program in patients with subacromial impingement syndrome: a systematic review. *Journal of Exercise Rehabilitation*, 16(3), 216–226. <https://doi.org/10.12965/jer.2040256.128>
- Schoenfeld, B. J., Ogborn, D., & Krieger, J. W. (2017). Dose-response relationship between weekly resistance training volume and increases in muscle mass: A systematic review and meta-analysis. *Journal of Sports Sciences*, 35(11), 1073–1082. <https://doi.org/10.1080/02640414.2016.1210197>
- Schoenfeld, B. J., Ratamess, N. A., Peterson, M. D., Contreras, B., Sonmez, G. T., & Alvar, B. A. (2014). Effects of Different Volume-Equated Resistance Training Loading Strategies on Muscular Adaptations in Well-Trained Men. *Journal of Strength and Conditioning Research*, 28(10), 2909–2918. <https://doi.org/10.1519/JSC.0000000000000480>
- Shiwa, S. R., Costa, L. O. P., Costa, L. da C. M., Moseley, A., Junior, L. C. H., Venâncio, R., Ruggero, C., Sato, T. de O., & Lopes, A. D. (2011). Reproducibility of the Portuguese version of the PEDro Scale. *Cadernos de Saúde Pública*, 27(10), 2063–2068. <https://doi.org/10.1590/S0102-311X2011001000019>
- Van der Windt, D. A., Koes, B. W., Boeke, A. J., Devillé, W., De Jong, B. A., & Bouter, L. M. (1996). Shoulder disorders in general practice: prognostic indicators of outcome. *The British Journal of General Practice: The Journal of the Royal College of General Practitioners*, 46(410), 519–523. <http://www.ncbi.nlm.nih.gov/pubmed/8917870>
- Virta, L., Joranger, P., Brox, J. I., & Eriksson, R. (2012). Costs of shoulder pain and resource use in primary health care: a cost-of-illness study in Sweden. *BMC Musculoskeletal Disorders*, 13(1), 17. <https://doi.org/10.1186/1471-2474-13-17>
- Yamakawa, E. K., Kubota, F. I., Beuren, F. H., Scalvenzi, L., & Miguel, P. A. C. (2014). Comparativo dos softwares de gerenciamento de referências bibliográficas: Mendeley, EndNote e Zotero. *Transinformação*, 26(2), 167–176. <https://doi.org/10.1590/0103-37862014000200006>