UNDERGRADUATE RESEARCH IN NATURAL AND CLINICAL SCIENCE AND TECHNOLOGY (URNCST) JOURNAL
Read more URNCST Journal articles and submit your own today at: https://www.urncst.com

REVIEW OPEN ACCESS

Comparative Effects of Low- and High-Intensity Exercise on Shoulder Joint Function, Stability, and Injury Risk: A Literature Review

Aleksandra Shuster, BSc Student [1]*

[1] Department of Life and Health Sciences, School of Sciences and Engineering, University of Nicosia, Nicosia, Cyprus, CY-2417

*Corresponding Author: alexashusterpl@gmail.com

Abstract

Introduction: Shoulder dysfunction is prevalent and frequently managed through exercise, but the effect of exercise intensity its effects are still uncertain. This review explored the effects of low, moderate, and high intensities on biomechanics, pain, and functionality in healthy people, athletes, and individuals with shoulder issues.

Methods: A comprehensive review encompassing 45 studies conducted between 2000 and 2025 was performed. The studies were categorized based on the type of population and exercise intensity, with results combined for strength, flexibility, neuromuscular coordination, and injury prevention.

Results: Low- to moderate-intensity exercise proved most beneficial for rehabilitation, especially for conditions like rotator cuff issues, subacromial pain, and adhesive capsulitis. It improved mobility, reduced pain, and enhanced function without overloading the joints. In athletes, programs focusing on high loads and proprioception improved performance and lowered the risk of injuries, while too much loading led to increased instability. For healthy individuals, using moderate loads maximizes muscle activation and control without causing excessive stress.

Discussion: Research suggests that training intensity must be tailored to specific populations. Rehabilitation is most effective with low-to-moderate loads, whereas athletes might need to engage in higher intensities within regulated environments. Important gaps in research are the absence of long-term studies, few comparisons between different intensities, and a lack of distinction based on sex, age, and occupation.

Conclusion: The intensity of exercise plays a crucial role in maintaining shoulder health. For rehabilitation, using low to moderate weights is best, whereas appropriately managed heavier weights can be advantageous for athletes. Future research should emphasize long-term results and uniform biomechanical assessments to develop evidence-based guidelines.

Keywords: shoulder joint; exercise intensity; athletic training; load management; joint stability; injury prevention; range of motion; chronic shoulder pain

Introduction

Shoulder pain is one of the most common musculoskeletal issues, affecting up to 67% of people at some point in their lives [1]. Due to its high prevalence and significant impact on daily activities, physical therapy and exercise-based treatments are often recommended as the first option. However, despite their widespread use, it is still unclear how different exercise intensities—low, moderate, or high—affect shoulder pain, biomechanics, and overall function. Early rehabilitation usually emphasizes low-intensity exercise to reduce symptoms and tissue stress [2], while higher intensities help improve strength and performance but can increase the risk of injury. Many studies have looked at these approaches separately, but far fewer have compared the effects of different intensity levels across various populations [3]. This highlights the need for a more integrated understanding.

The shoulder is the most mobile joint in the human body. It allows a wide range of movements, including flexion, extension, abduction, adduction, and rotation [4]. Structurally, it operates as a ball-and-socket synovial joint formed by the humeral head and the glenoid cavity [5]. Additional parts, such as the scapula, clavicle, acromioclavicular joint, sternoclavicular joint, ligaments, and the muscles that stabilize the rotator cuff and scapula, work together to provide both stability and mobility [6–10]. This complex balance makes the joint very functional but also prone to injury.

Common shoulder problems include rotator cuff-related shoulder pain (RCRSP), subacromial pain syndrome (SAPS), and adhesive capsulitis. These conditions all limit movement and strength [11–13]. Other factors that contribute to dysfunction are hypermobility [14, 15], poor scapular control [8], and post-stroke subluxation [16].

Exercise works well for many of these issues, but the best loading intensity is still unclear. Lower loads decrease pain and improve basic function [17]. Moderate loads improve neuromuscular coordination, while high loads can boost performance, especially in athletes. However, high loads also come with a higher risk of injury [18, 19].

Despite considerable research, several knowledge gaps still exist. There is limited comparison between similar demographic groups, a lack of long-term follow-ups, under-examined responses based on sex and age, and inconsistent measurements of biomechanics, such as EMG, torque, and scapular motion. This review investigates how low, moderate, and high-intensity exercise impacts shoulder biomechanics, pain, and functions in three specific groups: healthy individuals, athletes, and those with shoulder disorders.

These groups were chosen because they represent the full range of shoulder use in real life. Injured individuals show rehabilitation needs and reduced tissue tolerance. Healthy participants offer a baseline for normal shoulder function and prevention. Athletes represent high-demand situations that require strength, power, and precise control. Looking at all three groups gives a well-rounded view from recovery to daily activities, to elite performance.

Research Question

Our research question is pivotal to our study: How does the intensity of physical exercise influence the biomechanics of the shoulder joint, the level of discomfort, and functional outcomes in healthy individuals, professional athletes, and patients with shoulder diseases? This question forms the basis of our systematic review, where we analyze and synthesize data from the existing scientific literature.

Methods

This systematic review was conducted in accordance with established methodological principles to ensure comprehensive and reproducible identification of relevant evidence on the effects of exercise intensity on the glenohumeral (shoulder) joint. A structured search was performed across three major electronic databases — Google Scholar, PubMed, and MEDLINE (via OVID) — using a predefined set of keywords and Boolean operators, including shoulder joint, training, high-intensity, and low-intensity loads. The initial search yielded 50 English-language articles. Eligibility assessment followed strict inclusion and exclusion criteria. Included studies had to be peer-reviewed original research articles conducted exclusively on human participants, published between 2000 and 2025, and written in English. They were required to examine the effect of exercise intensity (low, moderate, or high) on the shoulder joint and involve at least one of the following populations: healthy individuals, athletes, or individuals with shoulder pathologies (either comparatively or as standalone cohorts). Furthermore, studies needed to report at least one of the key outcomes: pain (using validated scales such as VAS or NRS), range of motion (ROM), electromyography (EMG) data, scapular kinematics, torque (isometric or isokinetic), or injury risk/incidence. Conversely, the exclusion criteria encompassed animal studies, research limited to postoperative rehabilitation, case reports or series with fewer than 10 participants, articles without full-text access, studies lacking explicit intensity specification, and research focused on non-shoulder anatomical regions.

The screening and data extraction process was carried out systematically. Titles and abstracts were independently reviewed by two investigators to assess initial eligibility, followed by detailed evaluation of full texts for potentially relevant studies. Data extraction utilized a standardized form to capture essential variables: year and country of publication, participant characteristics (healthy, injured, athlete), presence and type of shoulder pathology, specific anatomical focus within the shoulder complex, type and intensity of intervention, primary and secondary outcome measures, and injury risk metrics (when available). The extracted data were then synthesized to evaluate the differential impact of exercise intensity across population subgroups. Findings were organized thematically to address the review's primary objective — to elucidate how varying levels of physical loading influence shoulder biomechanics, function, and injury risk in different populations (healthy individuals, athletes, and those with shoulder pathologies). This systematic approach enabled a comprehensive, evidence-based analysis of current knowledge in the field, ensuring robustness and transparency in assessing the relationship between exercise intensity and shoulder joint outcomes.

Results

Selection of Sources

A comprehensive analysis of the scientific literature revealed 38,022 publications in the PubMed, Medline OVID, and Google Scholar databases. After a rigorous selection process, we included 50 studies in our review, of which five were duplicates, allowing us to use 45 unique articles. These studies were diverse, covering three main groups: patients with joint problems (n = 24), professional athletes (n = 8), and healthy individuals without shoulder girdle pathologies (n = 13). The studies were conducted in various countries, mainly the United States, Denmark, and South Korea. The time range of publications spanned from 2000 to 2025, with a noticeable surge in the number of studies in 2024, indicating a growing interest in physical activity and shoulder girdle health in recent years.

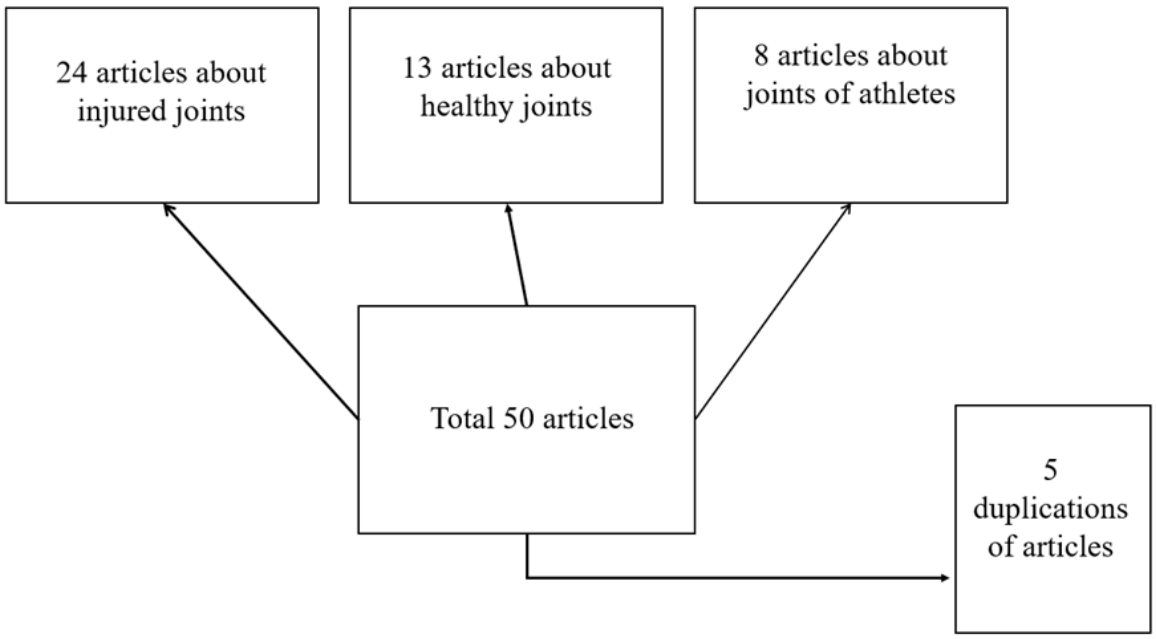

Figure 1. Flow diagram illustrating the classification of articles included in the review, created with Microsoft PowerPoint. A total of 50 articles were initially identified and categorized into three main groups based on population type: 24 articles addressed injured shoulder joints, 13 focused on healthy joints, and eight involved athletic populations. Five duplicate articles were identified and removed during the screening process, resulting in 45 unique studies used in the final analysis.

Injured Joints

Table 1 summarizes the outcomes from 24 studies investigating rehabilitation methods for shoulder injuries. Programs based on the FITT principle demonstrated continuous improvement in pain reduction and increased functionality in rotator cuff-related shoulder pain (RCRSP) [2], whereas protocols requiring pain-free exercise showed no additional benefits—painless exercise yielded similar results [20]. In individuals with subacromial pain syndrome (SAPS), scapula stabilization was consistently associated with decreased pain levels and enhanced functionality [21, 22]; a meta-analysis further confirmed that stabilization led to lower pain scores and improved disability metrics, particularly when combined with glenohumeral exercises rather than implemented as standalone scapular programs [17, 23]. Five studies evaluating manual therapy reported moderate benefits, with the most pronounced effects observed during long-term follow-up, though these did not exceed the efficacy of exercise [24, 25]. Neuromuscular control exercises improved active range of motion (ROM) and reduced pain intensity [26], while protocols focusing on grip strength significantly increased shoulder torque when direct rotator cuff loading was not feasible [27]. High-intensity training proved effective in managing hypermobility spectrum disorders by enhancing stability and decreasing pain [14], and for post-stroke individuals, sling-based methods reduced subluxation severity and improved upper limb assessment scores [28]. Overall, 20 out of 24 studies on injured joints (83%) reported notable reductions in pain and disability: low-load interventions were particularly effective for conditions such as adhesive capsulitis, diabetes-related capsulitis, and early post-stroke stages, whereas higher loads offered advantages for chronic instability syndromes.

Athlete Joints

Eight studies investigated exercise interventions among athletic populations (Table 2). In overhead athletes with impingement, suspension training (TRX) was found to be more effective than open kinetic chain exercises in enhancing proprioception [19], while strength training regimens improved eccentric external rotation strength and addressed glenohumeral imbalances commonly observed in overhead sports [29]. For high school baseball pitchers, a structured strength training program resulted in a 51.1% reduction in combined shoulder and elbow injuries compared to programs that included only stretching [18], and volleyball players participating in the 11+S program did not show notable improvements in proprioception but demonstrated enhanced dynamic stability [30]. Multiple reports emphasized the importance of training frequency consistency, with one to two weekly sessions proving sufficient to maintain strength gains after the initial conditioning phases. Recent research has also explored innovative sport-specific stabilization techniques in conjunction with traditional scapular exercises, with initial findings indicating equal or enhanced improvements in dynamic control [31]. Overall, in athlete studies, programs

focusing on strength and proprioception were associated with decreased injury rates and better performance indicators; six out of the eight studies (75 %) reported significant reductions in pain or injury risk.

Healthy Joints

Thirteen studies investigated the effects of exercise in healthy individuals without any history of shoulder issues (Table 3). Exercises targeting lying scapular retraction were found to engage stabilizing muscles—including the middle and lower trapezius and serratus anterior—thereby enhancing scapular movement patterns [32]. When comparing resistance levels, medium-intensity external rotation produced the optimal balance of torque and EMG activity without compensatory movements, whereas high-intensity exercise increased EMG activity but did not lead to further improvements in torque [33]. Aerobic exercises for the lower body were shown to temporarily raise shoulder pain thresholds, providing evidence of systemic hypoalgesic effects [34]. In older adults, a combined regimen of walking and elastic-band exercises improved scapular posture and alignment [35].

Study Designs

Among the 45 studies analyzed, randomized controlled trials (RCTs) made up the largest share, with 34 studies representing 76%. The other studies included five meta-analyses and systematic reviews (11%), two pilot studies (4.5%), three protocol descriptions (7%), and one case report (2%). Participant numbers ranged from 15 to 200. Small sample studies were those with 15 to 30 participants and typically focused on specific athletic groups. Rehabilitation-oriented research usually involved moderate sample sizes of 30 to 80 participants. Studies examining healthy individuals often included larger groups, with 80 to 200 participants. The duration of interventions generally ranged from 4 to 12 weeks, with training sessions held two to four times a week. Only six studies lasted more than six months, mainly looking at long-term outcomes or preventing reinjury. Control groups usually received basic care, stretching routines, or standard physiotherapy. Targeted interventions, such as TRX training, neuromuscular training, or manual therapy, often included multiple comparison groups.

Intervention Features

The usual interventions included various exercise methods, such as scapular stabilization, neuromuscular training, TRX or suspension-based stability exercises, resistance training with different weights, isokinetic eccentric programs, and hand-grip exercises [2, 19, 27]. Light loads were mainly used in rehabilitation and pain-management programs [24, 25]. The focus here was on safe movement and reducing symptoms. Moderate loads were generally utilized in studies with healthy participants. The goal was to improve torque production and optimize EMG activity, showing better neuromuscular efficiency [32, 33]. High loads were mostly recommended for athletes and people with hypermobility. These loads showed benefits for power, tendon stiffness, and joint control. However, they also carried a higher risk if not supervised [18, 36].

Measurement Instruments

The SPADI scales, the Constant-Merli scale, and the simplified shoulder test were used to assess pain. Torque and force were measured using manual muscle testing and isokinetic dynamometry. Biomechanical studies included measuring electromyographic activity and finite element modeling. The kinematic analysis focused on observing the scapula and the acromial movement patterns.

Summary Statistics and Patterns

Of the 45 studies examined, 53 % (n = 24) involved populations with injuries, 29% (n = 13) included healthy participants, and 18% (n = 8) focused specifically on athletes. Across all categories, 88% (n = 40) reported significant positive outcomes in terms of pain relief, range of motion (ROM), or functional performance, with low-to-moderate-intensity exercise most associated with beneficial effects, whereas high-intensity programs demonstrated more targeted but limited benefits. Regarding intervention design, integrated multi-joint approaches accounted for 58% of the programs, while isolated single-joint methods comprised 42%. Publication trends revealed a notable increase in research output after 2020, with 2024 marking the year with the highest number of relevant studies.

Discussion

This review examined 45 studies on how different exercise intensities affect shoulder mechanics, pain, and function in injured patients, healthy people, and athletes. The overall findings suggest that exercise intensity should be tailored to the individual based on their group, diagnosis, and training needs.

Low-intensity exercise was consistently the most effective for injured individuals, including those with rotator cuff issues, subacromial pain syndrome, and adhesive capsulitis. This type of exercise minimizes mechanical stress on inflamed tissues, reduces compression of the rotator cuff and subacromial space, and supports early healing by improving circulation and activating stabilizing muscles without causing pain. These factors help explain why scapular-focused and neuromuscular control programs reliably reduce pain and restore function in clinical populations [2, 23, 26]. Grip-strength approaches also showed value, especially when direct loading was not tolerated [17, 27].

For healthy individuals, moderate-intensity loading produced the best biomechanical outcomes. It offered a good balance between EMG activation and torque generation [32, 33]. This intensity range improves

neuromuscular efficiency and strength while reducing fatigue and tissue strain. In contrast, high intensity loading increased tendon stress [36], which makes it less suitable for general strengthening.

High-intensity programs that include proprioceptive and eccentric components are most effective for meeting athletic performance needs. Athletes saw benefits such as improved tendon stiffness, increased power output, and lower injury rates, with a greater than 50% drop in throwing-related injuries among baseball pitchers [18]. TRX-based and neuromuscular training also improved proprioceptive ability [19]. However, these programs need supervision and gradual load increases because of their higher mechanical demands and related injury risks.

Despite generally positive outcomes, there are still significant inconsistencies in the literature. Studies varied in their training protocols, population characteristics, and, importantly, in how they defined "high and moderate" intensity. Differences in EMG, ROM, and torque measurement methods also make it hard to compare studies directly. These inconsistencies show that there is a lack of standardized criteria and a need for more consistent methods in future research.

Clinical Implications

Exercise intensity must be individualized according to diagnosis, tissue tolerance, and stage of recovery. Low loads suit early rehabilitation, moderate loads support functional strengthening, and high loads should be reserved for prepared athletes under supervision, with careful progression to maintain safety.

Future Research

Future research should standardize intensity definitions, include long-term follow-up, and examine sex- and age-specific responses to loading. More precise biomechanical assessment, including 3D scapular motion and muscle activation, is needed, as well as development of sport-specific RTS criteria.

Figure 1

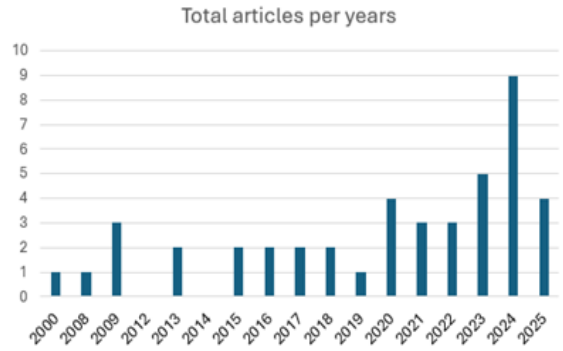

Figure 2

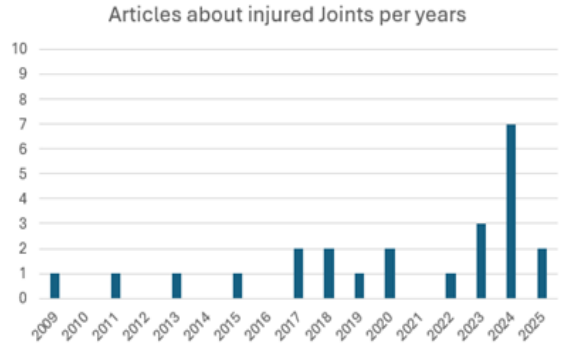

Figure 3

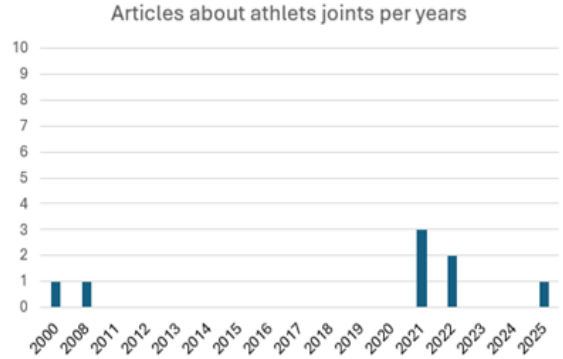

Figure 4

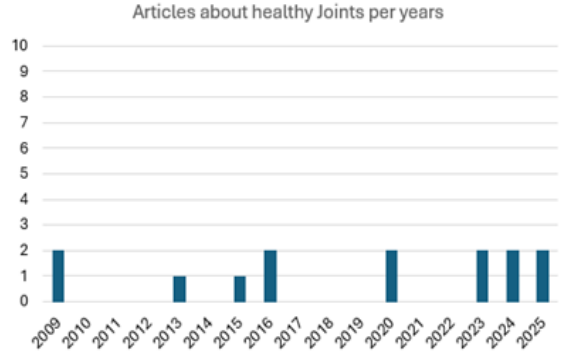

Figure 2. Articles about injured joints per year, created with Microsoft PowerPoint and Excel. This figure illustrates the yearly distribution of published articles focusing on injured shoulder joints from 2000 to 2025. The number of publications remained relatively low and stable until 2017, followed by a noticeable upward trend starting in 2020. A significant spike is observed in 2024, which reflects a surge of research interest in rehabilitation and therapeutic approaches for shoulder injuries. This aligns with broader trends in sports medicine and musculoskeletal research emphasizing conservative, exercise-based treatments in recent years.

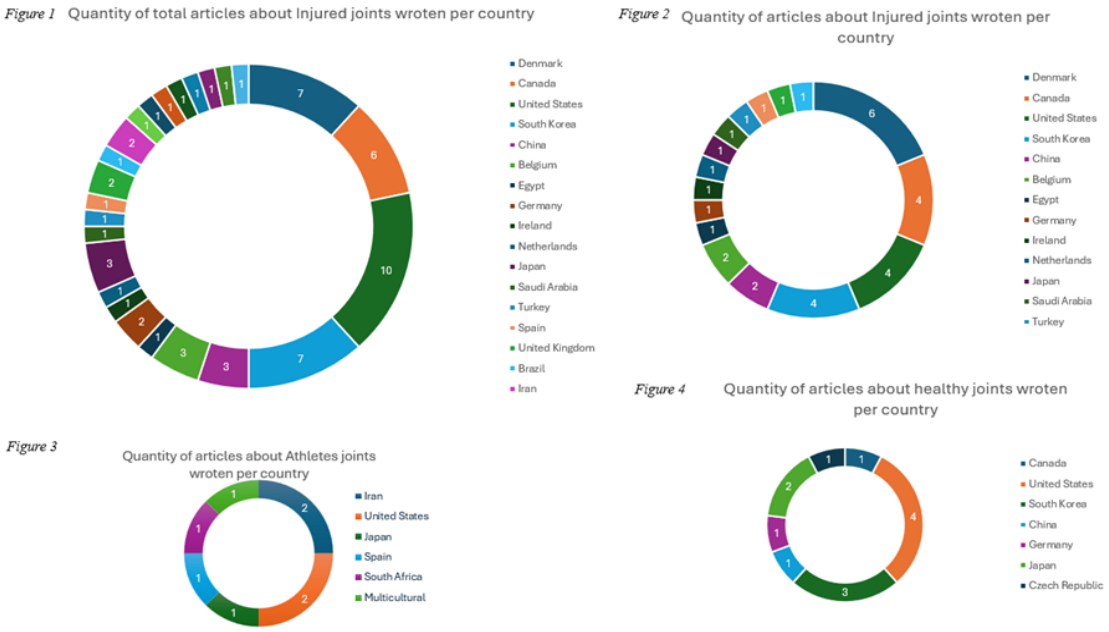

Figure 3. This slide presents the geographic distribution of studies on shoulder joint health across different population groups, created with Microsoft PowerPoint and Excel. Most of the research on injured joints comes from the United States and Denmark. Articles on athlete joints are more evenly distributed, with key contributions from Iran and the U.S. Studies on healthy joints were mainly conducted in Canada, the U.S., and South Korea. Together, the charts highlight global trends in shoulder joint research by country and population type.

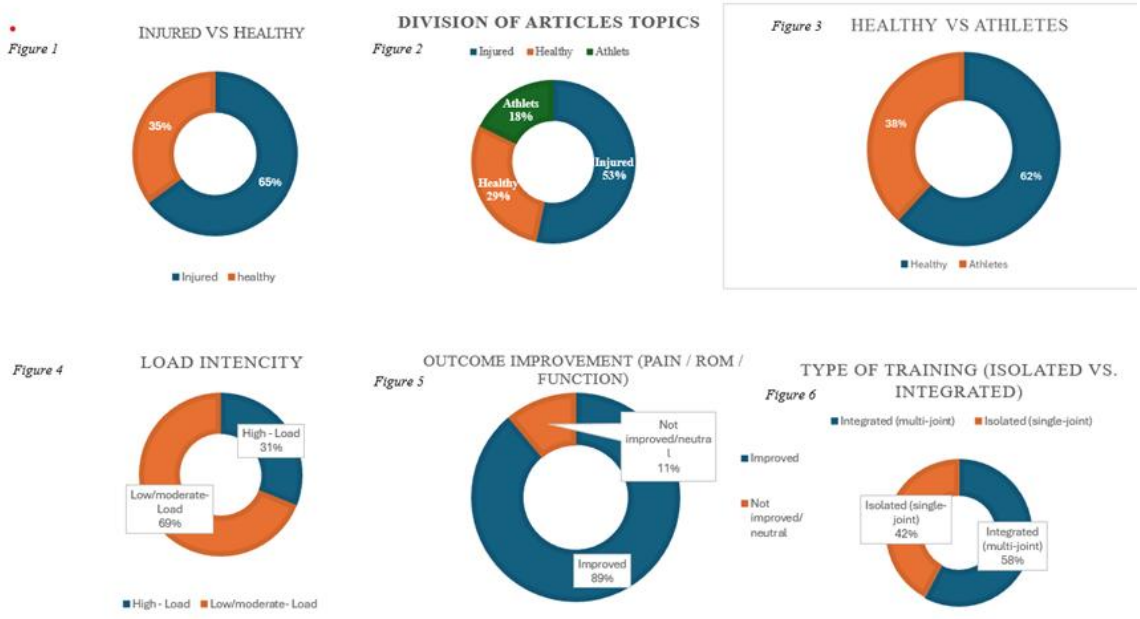

Figure 4. Shows the cumulative analysis of training parameters and outcomes across the reviewed literature, created with Microsoft PowerPoint and Excel. It demonstrates that most interventions utilized low to moderate intensity loads (69%), with a preference for multi-joint (integrated) exercises (58%) over isolated movements. Notably, 89% of the studies reported clinical improvement in pain, range of motion, or function, underscoring the high efficacy of these approaches. The data further suggests that conservative, functionally integrated loading strategies are most associated with positive rehabilitation outcomes.

Conclusions

This review notes that the intensity of physical exercise plays a key role in maintaining shoulder health, injury recovery, and overall performance. Low- and moderate-load programs, especially those focusing on shoulder blade stabilization and neuromuscular control, are most effective for people with injuries. At the same time, more intense training combined with proprioceptive training helps to increase strength and reduce the risk of injury in athletes. For uninjured individuals, moderate-intensity exercise is most effective for optimizing muscle activity and control, and alternative indirect training ensures safety. These results emphasize the necessity of tailored, context-specific training programs. Future studies should explore long-term effects, establish standardized definitions of intensity, and create sport-specific return-to-sport (RTS) protocols to support evidence-based practice.

Abbreviations

EMG: electromyography (muscle activity measurement)
FITT principle: frequency, intensity, time, type (exercise prescription guideline)
RCRSP: rotator cuff–related shoulder pain
RCT: randomized controlled trial
ROM: range of motion
RTS: return to sport
SAPS: subacromial pain syndrome
SPADI: shoulder pain and disability index
SST: simple shoulder test
TRX: total resistance exercises (suspension training system)

Conflicts of Interest

The author (Aleksandra Shuster) declares that there are no conflicts of interest.

Ethics Approval and/or Participant Consent

This study did not require review by a Research Ethics Board (REB), as it is a literature review based exclusively on previously published studies. No human participants or personal data were directly involved, and therefore no consent to participate was necessary.

Authors' Contributions

AS: conceived and designed the study, conducted the literature search, collected and analysed data, drafted and revised the manuscript, and approved the final version for publication.

Acknowledgements

The author confirms that all aspects of this study, including literature search, analysis, and manuscript preparation, were completed independently by the author without external assistance.

Funding

This study was not funded.

References

[1] Luime J, Koes B, Hendriksen I, Burdorf A, Verhagen A, Miedema H et al. Prevalence and incidence of shoulder pain in the general population; a systematic review. Scand J Rheumatol, 2004; 33(2): 73–81. https://doi.org/10.1080/03009740310004667
[2] Lafrance S, Charron M, Dubé M O, Desmeules F, Roy J S, Juul-Kristensen B et al. The Efficacy of exercise therapy for Rotator Cuff-Related Shoulder Pain according to the FITT principle: A systematic review with meta-analyses. *JOSPT*, 2024; *54*(8): 499–512. https://doi.org/10.2519/jospt.2024.12453
[3] Silveira A, Lima C, Beaupre L, Chepeha J, Jones A. Shoulder specific exercise therapy is effective in reducing chronic shoulder pain: A network meta-analysis. *PLoS ONE*, 2024; *19*(4): e0294014. https://doi.org/10.1371/journal.pone.0294014
[4] Moore K L, Dalley A F, Agur A M R. *Moore's Clinically Oriented Anatomy.* 8th ed. Philadelphia (PA): Lippincott Williams & Wilkins; 2018.
[5] Standring S. *Gray's anatomy: The Anatomical Basis of Clinical Practice*. 40th ed. London: Churchill Livingstone Elsevier; 2008.
[6] Kwon Y W, Powell K A, Yum J K, Brems J J, Iannotti J P. Use of three-dimensional computed tomography for the analysis of the glenoid anatomy. *JSES*, 2005; *14*(1): 85–90. https://doi.org/10.1016/j.jse.2004.04.011
[7] Escamilla R F, Yamashiro K, Paulos L, Andrews J R. Shoulder muscle activity and function in common shoulder rehabilitation exercises. *Sports Medicine (Auckland, N.Z.)*, 2009; *39*(8): 663–685. https://doi.org/10.2165/00007256-200939080-00004
[8] Kibler W B, Ludewig P M, McClure P W, Michener L A, Bak K, Sciascia A D. Clinical implication of scapular dyskinesis in shoulder injury: the 2013 consensus statement from the 'Scapular Summit'. *BJSM*, 2013; *47*(14): 877–885. https://doi.org/10.1136/bjsports-2013-092425
[9] Fox A J S, Fox O J K, Schär M O, Chaudhury S, Warren R F, Rodeo S A. The glenohumeral ligaments: Superior, middle, and inferior: Anatomy, biomechanics, injury, and diagnosis. *Clinical Anatomy (New York, N.Y.)*, 2021; *34*(2): 283–296. https://doi.org/10.1002/ca.23717
[10] Wilk K E, Obma P, Simpson C D, Cain E L, Dugas J R, Andrews J R. Shoulder injuries in the overhead athlete. *JOSPT*, 2009; *39*(2): 38–54. https://doi.org/10.2519/jospt.2009.2929
[11] Lewis J. Rotator cuff related shoulder pain: Assessment, management and uncertainties. *Manual Therapy*, 2016; *23*: 57–68. https://doi.org/10.1016/j.math.2016.03.009

[12] Tighe C B, Oakley W S Jr. The prevalence of a diabetic condition and adhesive capsulitis of the shoulder. *SMJ*, 2008; *101*(6): 591–595. https://doi.org/10.1097/smj.0b013e3181705d39

[13] Zreik N H, Malik R A, Charalambous C P. Adhesive capsulitis of the shoulder and diabetes: A meta-analysis of prevalence. *MLTJ*, 2016; *6*(1): 26–34. https://doi.org/10.32098/mltj.01.2016.04

[14] Liaghat B, Juul-Kristensen B, Faber D A, Christensen E O, Søgaard K, Skou S T et al. One-year effectiveness of high-load compared with low-load strengthening exercise on self-reported function in patients with hypermobile shoulders: A secondary analysis from a randomised controlled trial. *BJSM*, 2024; *58*(7): 373–381. https://doi.org/10.1136/bjsports-2023-107563

[15] Liaghat B, Skou S T, Jørgensen U, Sondergaard J, Søgaard K, Juul-Kristensen B. Heavy shoulder strengthening exercise in people with Hypermobility Spectrum Disorder (HSD) and long-lasting shoulder symptoms: A feasibility study. *Pilot and Feasibility Studies*, 2020; *6*: 97. https://doi.org/10.1186/s40814-020-00632-y

[16] Ada L, Foongchomcheay A. Efficacy of electrical stimulation in preventing or reducing subluxation of the shoulder after stroke: A meta-analysis. *Aust J Physiother*, 2002; *48*(4): 257–267. https://doi.org/10.1016/s0004-9514(14)60165-3

[17] Jeon N-Y, Chon S-C. Effect of glenohumeral stabilization exercises combined with scapular stabilization on shoulder function in patients with shoulder pain: A randomized controlled experimenter-blinded study. *J Back Musculoskelet Rehabil*, 2018; 31(2): 259-265. https://doi.org/10.3233/bmr-169612

[18] Shitara H, Tajika T, Kuboi T, Ichinose T, Sasaki T, Hamano N et al. Shoulder stretching versus shoulder muscle strength training for the prevention of baseball-related arm injuries: A randomized, active-controlled, open-label, non-inferiority study. *Scientific Reports*, 2022; *12*(1): 22118. https://doi.org/10.1038/s41598-022-26682-1

[19] Saadatian A, Babaei K M, Sahebozamani M, Taghi K M. The impact of OKC exercises and TRX exercises on shoulder joint proprioception in overhead athletes with shoulder impingement syndrome: A randomized controlled trial. *PTJ*, 2022; 12(2): 77–84. https://doi.org/10.32598/ptj.12.2.519.1

[20] Cavaggion C, Luque-Suarez A, Voogt L, Juul-Kristensen B, Wollants G, Beke L et al. Exercise into pain in chronic rotator cuff-related shoulder pain: A randomized controlled trial with 6-month follow-up. *Open Access J Sports Med*, 2024; 15: 181-196. https://doi.org/10.2147/oajsm.s483272

[21] Yuksel E, Yesilyaprak S S. Scapular stabilization exercise training improves treatment effectiveness on shoulder pain, scapular dyskinesis, muscle strength, and function in patients with subacromial pain syndrome: A randomized controlled trial. *JBMT*, 2024; *37*: 101–108. https://doi.org/10.1016/j.jbmt.2023.11.005

[22] Roy J S, Moffet H, Hébert L J, Lirette R. Effect of motor control and strengthening exercises on shoulder function in persons with impingement syndrome: A single-subject study design. *Manual Therapy*, 2009; *14*(2): 180–188. https://doi.org/10.1016/j.math.2008.01.010

[23] Zhong Z, Zang W, Tang Z, Pan Q, Yang Z, Chen B. Effect of scapular stabilization exercises on subacromial pain (impingement) syndrome: A systematic review and meta-analysis of randomized controlled trials. *Front. Neurol*, 2024; 15: 1357763. https://doi.org/10.3389/fneur.2024.1357763

[24] Camargo PR, Alburquerque-Sendín, Avila M A, Haik M N, Vieira A, Salvini TF. Effects of stretching and strengthening exercises, with and without manual therapy, on scapular kinematics, function, and pain in individuals with shoulder impingement: A randomized controlled trial. *JOSPT, 2015; 45(12): 984–997.* https://doi.org/10.2519/jospt.2015.5939

[25] Michener LA, McClure PW, Tate AR, Bailey LB, Seitz AL, Straub RK et al. Adding manual therapy to an exercise program improves long-term patient outcomes over exercise alone in patients with subacromial shoulder pain: A randomized clinical trial. *JOSPT, 2024; 2(1):* 29-48. https://doi.org/10.2519/josptopen.2023.1134

[26] Wang L, Yu G, Zhang R, Wu G, He L, Chen Y. Positive effects of neuromuscular exercises on pain and active range of motion in idiopathic frozen shoulder: A randomized controlled trial. *BMC*, 2023; *24*(1): 50. https://doi.org/10.1186/s12891-023-06173-8

[27] Kachanathu S, Zedan A M E, Hafez A R, Alodaibi F A, Alenazi A M, Nuhmani S. (2019). Effect of shoulder stability exercises on hand grip strength in patients with shoulder impingement syndrome. *Somatosens Mot Res*, 2019; *36*(2): 97–101. https://doi.org/10.1080/08990220.2019.1604335

[28] Kim Y-J, An J, Lee B-H. Effects of sling-suspension-based active shoulder joint exercise on shoulder joint subluxation, pain, muscle strength, and upper limb function in patients with subacute stroke. *Medicina*, 2024; *60*(8): 1350. https://doi.org/10.3390/medicina60081350

[29] Niederbracht Y, Shim A L, Sloniger M A, Paternostro-Bayles M, Short T H. Effects of a shoulder injury prevention strength training program on eccentric external rotator muscle strength and glenohumeral joint imbalance in female overhead activity athletes. *JSCR*, 2008; *22*(1): 140–145. https://doi.org/10.1519/jsc.0b013e31815f5634

[30] Zarei M, Eshghi S, Hosseinzadeh M. The effect of a shoulder injury prevention programme on proprioception and dynamic stability of young volleyball players; A randomized controlled trial. *BMC*, 2021; *13*(1): 71. https://doi.org/10.1186/s13102-021-00300-5

[31] Guérineau F, Almazán-Polo J, González-de-la-Flor Á. Effectiveness of a sport-specific exercise programme for overhead athletes with unilateral subacromial shoulder pain: A study protocol of a randomised controlled trial. *BMJ*, 2025; *11*(1): e002523. https://doi.org/10.1136/bmjsem-2025-002523

[32] Schory A, Bidinger E, Wolf J, Murray L. A systematic review of the exercises that produce optimal muscle ratios of the scapular stabilizers in normal shoulders. *IJSPT*, 2016; *11*(3): 321–336. https://pubmed.ncbi.nlm.nih.gov/27274418/

[33] Saeki Y, Kubota A, Kishimoto K, Inoue M, Inoue T, Takazawa Y. Effect of different load of shoulder external rotation exercises on changes in muscle activity and exerted torque. *Front Sports Act Living,* 2025; 7: 1527296. https://doi.org/10.3389/fspor.2025.1527296

[34] Wassinger C A, Lumpkins L, Sole G. Lower extremity aerobic exercise as a treatment for shoulder pain. *Int J Sports Phys Ther*, 2020; *15*(1): 74–80. https://doi.org/10.26603/ijspt20200074

[35] Novotová K, Pavlů D. Influence of walking, manual techniques, and elastic resistance exercise on shoulder posture in healthy elderly individuals. *Geriatrics (Basel, Switzerland)*, 2024; *9*(5): 128. https://doi.org/10.3390/geriatrics9050128

[36] Yang Z, Xu G, Yang J, Li Z. Effect of different loads on the shoulder in abduction postures: A finite element analysis. *Scientific Reports*, 2023; *13*(1): 9490. https://doi.org/10.1038/s41598-023-36049-9

[37] Vetter S, Hepp P, Schleichardt A, Schleifenbaum S, Witt M, Roth C et al. Effect of isokinetic eccentric training on the human shoulder strength, flexibility, and muscle architecture in physically active men: A preliminary study. *PloS One*, 2023; *18*(12): e0293439. https://doi.org/10.1371/journal.pone.0293439

[38] Brudvig TJ, Kulkarni H, Shah S. The effect of therapeutic exercise and mobilization on patients with shoulder dysfunction: A systematic review with meta-analysis. *JOSPT,* 2011; 734-748. https://doi.org/10.2519/jospt.2011.3440

[39] Mueller M J, Sorensen C J, McGill J B, Clark B R, Lang C E, Chen L et al. Effect of a shoulder movement intervention on joint mobility, pain, and disability in people with diabetes: A randomized controlled trial. *Physical Therapy*, 2018; *98*(9): 745–753. https://doi.org/10.1093/ptj/pzy070

[40] Park S I, Choi Y K, Lee J H, Kim Y M. Effects of shoulder stabilization exercise on pain and functional recovery of shoulder impingement syndrome patients. *JPTS*, 2013; *25*(11): 1359–1362. https://doi.org/10.1589/jpts.25.1359

[41] Yan X, Zhou X-H, Kim T-H. The effects of a complex shoulder exercise program with respiratory training on muscle activity and posture in individuals exhibiting scapular internal rotation. *Applied Sciences*, 2025; *15*(1): 313. https://doi.org/10.3390/app15010313

[42] Elder A, Powers C M. Scapular stabilization for shoulder pain: Putting the cart before the horse? *IJSPT*, 2025; *20*(2): 275–282. https://doi.org/10.26603/001c.128049

[43] Shire A R, Stæhr T A B, Overby J B, Bastholm Dahl M, Sandell Jacobsen J, Høyrup Christiansen D. Specific or general exercise strategy for subacromial impingement syndrome-does it matter? A systematic literature review and meta-analysis. *BMC*, 2017; *18*(1): 158. https://doi.org/10.1186/s12891-017-1518-0

[44] Clausen MB, Bandholm T, Rathleff M, Christensen KB, Zebis MK, Graven-Nielsen T et al. The Strengthening Exercises in Shoulder Impingement trial (The SExSI-trial) investigating the effectiveness of a simple add-on shoulder strengthening exercise programme in patients with long-lasting subacromial impingement syndrome: Study protocol for a pragmatic, assessor blinded, parallel-group, randomised, controlled trial. *Trials,* 2018; 19: 154. https://doi.org/10.1186/s13063-018-2509-7

[45] Hara K, Matsuse H, Hashida R, Iwanaga S, Bekki M, Hara M et al. The effect of rotator cuff physical exercise combined with electrically stimulated antagonist on shoulder rotator cuff strength, *J Orthop Sci*, 2022; Volume 27, Issue 1: 126-130, ISSN 0949-2658. https://doi.org/10.1016/j.jos.2020.11.015

[46] Schedler S, Brueckner D, Hagen M, Muehlbauer T. Effects of a traditional versus an alternative strengthening exercise program on shoulder pain, function and physical performance in individuals with subacromial shoulder pain: A randomized controlled trial. *Sports*, 2020; *8*(4): 48. https://doi.org/10.3390/sports8040048

[47] McCarrick M J, Kemp J G. The effect of strength training and reduced training on rotator cuff musculature. *Clinical Biomechanics (Bristol, Avon)*, 2000; *15 Suppl 1*: S42–S45. https://doi.org/10.1016/s0268-0033(00)00060-7

[48] Schwank A, Blazey P, Asker M, Møller M, Hägglund M, Gard S et al. 2022 Bern consensus statement on shoulder injury prevention, rehabilitation, and return to sport for athletes at all participation levels. *JOSPT*, 2022; *52*(1): 11–28. https://doi.org/10.2519/jospt.2022.10952

[49] Swart J J W, Olivier B. Effectiveness of exercise interventions to prevent shoulder injuries in athletes: A systematic review protocol. *JBI*, 2021; *19*(10): 2847–2856. https://doi.org/10.11124/jbies-20-00465

[50] Choi S H, Lee B H. Clinical usefulness of shoulder stability exercises for middle-aged women. *J Phys Ther Sci*, 2013; *25*(10): 1243–1246. https://doi.org/10.1589/jpts.25.1243

[51] Kolber MJ, Beekhuizen KS, Cheng MS, Hellman MA. Shoulder joint and muscle characteristics in the recreational weight training population. *J Strength Cond Res*. 2009;23(1):148-157. https://doi.org/10.1519/JSC.0b013e31818eafb4

[52] Lee Y, Shin M M, Lee W. Effects of shoulder stabilization exercise on pain and function in patients with neck pain. *JPTS*, 2015; *27*(12): 3619–3622. https://doi.org/10.1589/jpts.27.3619

[53] Adamson S, Lorimer R, Cobley J N, Lloyd R, Babraj J. High intensity training improves health and physical function in middle aged adults. *Biology*, 2014; *3*(2): 333-344. https://doi.org/10.3390/biology3020333

[54] Cuff A, Littlewood C. Subacromial impingement syndrome - What does this mean to and for the patient? A qualitative study. *Musculoskelet Sci Pract*, 2018; *33*: 24–28. https://doi.org/10.1016/j.msksp.2017.10.008

[55] Huisstede B M, Bierma-Zeinstra S M, Koes B W, Verhaar J A. Incidence and prevalence of upper-extremity musculoskeletal disorders. A systematic appraisal of the literature. *BMC*, 2006; *7*: 7. https://doi.org/10.1186/1471-2474-7-7

[56] Knapik J J. Injuries during high-intensity functional training: Systematic review and meta-analysis. *J Spec Oper Med*, 2022; *22*(1): 121–129. https://doi.org/10.55460/g29p-i0au

[57] Kostopoulos D, Rawat M. Demystifying shoulder pain with electrodiagnosis and musculoskeletal ultrasound imaging. *JBMT*, 2017; *21*(4): 983–985. https://doi.org/10.1016/j.jbmt.2017.09.010

[58] Neer C S 2nd. Anterior acromioplasty for the chronic impingement syndrome in the shoulder: A preliminary report. *J Bone Joint Surg Am.* 1972; *54*(1): 41. https://doi.org/10.2106/00004623-197254010-00003

[59] Peeler J, Ripat J. The effect of low-load exercise on joint pain, function, and activities of daily living in patients with knee osteoarthritis. *The Knee*, 2018; *25*(1):135–145. https://doi.org/10.1016/j.knee.2017.12.003

[60] Yoma M, Herrington L, Mackenzie T A, Almond T A. Training intensity and shoulder musculoskeletal physical quality responses in competitive swimmers. *JAT*, 2021; *56*(1): 54–63. https://doi.org/10.4085/1062-6050-0357.19

Article Information
Managing Editor: Jeremy Y. Ng
Peer Reviewers: Amel Sassi, Harveen Saini
Article Dates: Received Aug 30 25; Accepted Jan 11 26; Published Mar 10 26

Citation
Please cite this article as follows:
Shuster A. Comparative effects of low- and high-intensity exercise on shoulder joint function, stability, and injury risk: A literature review. URNCST Journal. 2026 Mar 10: 10(3). https://urncst.com/index.php/urncst/article/view/938
DOI Link: https://doi.org/10.26685/urncst.938