Vol. 7, No. 1, 2026, pp. 1479-1495
DOI: https://doi.org/10.29210/993610

Contents lists available at Elora Center

Lentera Negeri

Journal homepage: https://lentera.eloracenter.org/lentera

Effects of static and dynamic stretching on sprint, jump, agility, power, and flexibility performance: a systematic review

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Article Info

Article history:
Received Aug 30th, 2026
Revised Sept 01st, 2026
Accepted Sept 07th, 2026

Keyword:
Static stretching,
Dynamic stretching,
Athletic performance,
Warm-up,
Systematic review

ABSTRACT

Static and dynamic stretching are routinely used in pre-competition warm-ups, yet their application remains inconsistent due to ongoing debate over their relative efficacy. This systematic review examined the acute and chronic effects of static, dynamic, and combined stretching on athletes' sprint speed, jump performance, muscular power, agility, and flexibility. Following PRISMA 2020 guidelines, a search was conducted using the Scopus database, resulting in 259 initial records. After screening and quality appraisal using the four-domain FICO framework, 50 studies were retained for qualitative and thematic synthesis; meta-analysis was omitted due to high outcome measure heterogeneity. Findings indicate that a single session of static stretching generally impaired maximal strength and jump performance, whereas dynamic stretching acutely enhanced sprint, agility, and vertical jump outcomes. Multi-week stretching programs improved flexibility and selected strength metrics without acute performance deficits, while combining stretching with other modalities (e.g., foam rolling) yielded mainly additive but inconsistent benefits. Consequently, practitioners should prioritize dynamic warm-ups immediately prior to competition and reserve static stretching for dedicated flexibility sessions. Future research should focus on dosage standardization, sport-specific metrics, and chronic intervention designs.

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Introduction

Warm-up strategies are considered one of the most vital aspects in contemporary sports science due to their dual effects on injury risk and immediate readiness for optimal performance in practically all kinds of sports competitions. Stretching, whether static or dynamic, is a common feature of a pre-competition routine and for good reason, except that the scientific justification of one method over the other has always been rather a disputed topic. In recent years, independent researchers working across different countries have moved toward a more consistent understanding of the issue (Afonso et al., 2024; Kłobuchowski et al., 2026). A coach, physical therapist, or conditioning expert who prepares the warm-up for a group can really affect the athletes' physical state, both a teenage player on a sports team and an Olympic champion. That is just to say that even the smallest change in a stretching program can result in a significant difference at a practical level (Behm et al., 2023; Kons et al., 2026). If one takes into account the fact that nearly everyone in the sports community resorts to stretching as the best way of preparing, then discovering the fact that the actual influence of stretching on performance might be very different from the one assumed is not just a research problem but something that has major implications for the way training is designed.

Set against the wider framework, the particular subject matter of this review is the relatively comparing static stretching vs. dynamic stretching with regard to athletes' measurable performance, such as sprint speed, vertical jump height, agility, muscular power and flexibility (Praveen et al., 2026; Millner et al., 2022). A major theory in exercise science, which is also quite old, states that prolonged static stretching sessions acutely reduce force and power, whereas dynamic stretching is claimed to either preserve or even increase neuromuscular readiness and, as such, it is a better stretching method for those involved in sports (Ji et al., 2026; Warneke et al., 2022). Nonetheless, this theory about SS and DS having contrasting effects has recently been contested by researchers pointing out that static stretching when done with the right dose and timing, does not have a negative effect or can even be beneficial. All in all, the discussion of SS as opposed to DS is far more complex than earlier reviews implied. Unlike prior narrative reviews, which have largely treated static and dynamic stretching as a simple either/or comparison, this review's novel contribution is to integrate acute, dose-response, and chronic evidence within a single PRISMA-guided synthesis, and to make the search strategy, eligibility criteria, and quality-appraisal process fully transparent for replication.

Many investigations have focused on how acutely stretching affects using random crossover designs in different athletes groups. Soccer-related (Šarabon et al., 2020; Barbosa et al., 2020), volleyball-related (Mielniczek & Tillaar, 2026; Eyuboglu et al., 2026), table tennis-related (Hsu et al., 2021) and handball-related (Chen et al., 2023) ones were also considered different research questions. In general, from what has been already written in the literature one can hardly talk of a simple generalization of the effect of stretching across sports because it heavily depends on such factors as targeted muscle group, the length of the stretch, and the nature of the performance measure used to capture the effect.

Newer methodologies and approaches have increased the ability to accurately detect stretching effects. Investigators have used markerless motion-capture to identify biomechanical parameters during a jump (Iranmanesh et al., 2026), associated stretching with foam rolling or vibration devices to identify additive effects (Dutta et al., 2023; Lyu et al., 2020), and carried out meta-analyses to synthesize jump-height and range-of-motion data across the trials (Esteban-García et al., 2024; Cuenca-Fernández et al., 2026). Although these methods have refined our knowledge, they have also uncovered significant variability in results between studies which was impossible or at least very difficult to appreciate with old-style non-systematic reviews.

Nevertheless, a major limitation is the fact that there is a lack of studies comparing various stretching methods, stretching tempos, and stretching times, as well as combined methods (e.g., stretch followed by percussion massage, neural gliding (NG), or proprioceptive neuromuscular facilitation (PNF)), mainly in small sport-specific studies with different parameters, which hardly ever reach standardized dosing parameters (Kabešová et al., 2025; Malek et al., 2024; Kurt et al., 2024; Menek& Tayboga, 2024). A systematic review of these protocols would greatly be needed. Until then, without a unified method, there is still a great uncertainty among professionals who use such studies which may not at all reflect the conditions their own athletes are undergoing.

Another methodological lack refers to the design and reporting quality of study. It has been pointed out that stretching research is largely based on small samples, acute single sessions, and inconsistent outcome measures, which prevent the establishment of the causal link related to chronic training outcomes (Afonso et al., 2024; Hendricks et al., 2020). As shown by stretching-adjacent rehabilitation research on tendinopathy (Niering & Muehlbauer, 2023), factors such as the concurrent injury history further hinder cross-study comparison, since clinical and performance-oriented populations often get pooled together without proper stratification.

It is the reason that led to the realization of the review that these two gaps were in need of a systematic review. As the types of stretching protocols are changing, it becomes very important in that regard to bring together different research papers on this topic.

There are so many various stretching methods being introduced, including static stretching (holding the stretch), dynamic stretching (bouncing through the stretch), the RAMP concept (a warm-up approach with specific movement patterns), and combining stretch with potentiation (exercise for muscle activation). Therefore, it is of great importance to collect all the scattered results on this topic in a clear and concise report that fits the standards of a PRISMA-compliant synthesis (Warneke et al., 2022; Rašković et al., 2025). This will not only help us in understanding what works, and how, but may also allow us to determine which of the methods can be recommended for use in practical situations. In those contexts where time for training is very limited, and therefore every minute of a warm-up must produce a direct benefit in terms of performance or injury prevention, one should not lose the opportunity to get acquainted with such a comprehensive knowledge (Kons et al., 2026).

In line with this reasoning, this current review focuses on three research questions. One of the questions is about how much and in which direction static and dynamic stretching influence the acute performance of strength, power, sprint, jump, and agility. Clarifying this helps provide a detailed, evidence-based overview that will, among other things, be of value for coaches in making up the pre-competition warm-up plan.

RQ1: *Compared with dynamic stretching, what are the acute effects of static stretching on such performances as strength, power, sprinting, jumping, and agility in athletes or physically active people?*

The second research question was on the role of intervention characteristics (duration, tempo, timing, and combination with adjunct modalities such as foam rolling or potentiation exercise) in performance response to stretching. This research provides a dose-response perspective, which previous narrative reviews of the topic have largely missed.

RQ2: *How does the combination of stretching duration, tempo, timing, and other types of physical warm-up influence athletic performance outcomes?*

The third research question explores to what extent long term stretching programs, that span several weeks, change performance and flexibility in a different way compared to a single stretching session and also if these differences are related to sport type or the characteristics of the individual athletes. In general, these three questions represent a very fresh and well balanced approach that helps to shift away from a series of single acute-effect studies to a coherent picture of both short- and long-term stretching outcomes across the field of athleticism.

RQ3: *What are the chronic (multi-week) effects of combining both static and dynamic stretches on the flexibility and performance of athletes, and how do these effects vary by sport type and athlete characteristics?*

Method

Research Design and Framework

This review used a systematic literature review approach as we thought that answering our questions would need a transparent and repeatable synthesis of a large and dissimilar collection of findings about different stretching practices in sport, which is in line with standards for evidence-based management or health-science review. Reporting of our review has followed the PRISMA 2020 standards, which set up a process with stages like search of papers, initial screening of titles/abstracts, full-text eligibility, and inclusion. It further mandates detailed records of numbers and reasons behind decisions at each stage. We chose it against a narrative review as latter is more likely to be biased in terms of paper selection, and we also found that meta-analysis would not be adequate since the outcomes reported by literature that we included, such as sit-and-reach distance, countermovement jump height, 10, 20 m sprint time, Illinois agility time, etc., are not homogeneous enough to allow pooled effect-size estimation without loss of interpretability being substantial. Concretely, converting distance-, time-, and angle-based outcomes onto a common standardized-mean-difference metric would have required assuming comparable variances and directionality across fundamentally different constructs (e.g., a change in centimetres of reach versus a change in seconds of sprint time), which we judged would obscure rather than clarify the true magnitude of stretching effects; a narrative, theme-based synthesis was therefore considered the more defensible approach for this evidence base.

Search Strategy

A Boolean search string was built which combined a stretching modality aspect with athletic performance, outcomes, which was searched in the title, abstract and keyword fields: ("static stretching" OR "dynamic stretching" OR "stretching exercises" OR "flexibility training" OR "warm-up") AND (("athletic performance" OR "sports performance" OR "physical performance" OR "muscle performance" OR "strength" OR "power" OR "sprint performance" OR "jump performance" OR "agility" OR "range of motion") AND ("athletes" OR "systematic review")).

Truncation and phrase-searching were done by means of putting the multi-word terms inside quotation marks; the search was limited to the TITLE-ABS-KEY field in Scopus. Since there was no language or date restriction during the search execution stage, these restrictions were applied to the eligibility screening described in Section 3.4. This is also in line with a conservative identification strategy aiming to maximize recall only after including criteria.

Database and Information Sources

We relied on Scopus as the only bibliographic source database for this review because it covers most peer-reviewed sources of the sports science, sports medicine, and human physiology areas. We performed the search on 22 of July, 2030, and the resulting file export contained 492 records with the corresponding metadata (author names/affiliation, publication year, source title, volume/issue, page range, DOI, abstract and the authors' keyword). Besides, databases, such as, PubMed or Web of Science, were not used in this version of the review we have to see it as a weakness, which we mentioned in section 5.5.

Eligibility Criteria

Table 1. Inclusion and Exclusion Criteria

Criterion	Inclusion	Exclusion
Language	English only	Non-English
Document type	Article, Review	Conference paper, Book chapter, Editorial/Note, Short survey, Retracted publication
Publication period	2020–2026 (search execution date)	Not applicable - no records predate 2020 in this export
Subject area	Sports science, sports medicine, exercise physiology, strength and conditioning, kinesiology	Unrelated disciplines with no stretching-performance focus
Identifiability	DOI available in Scopus record	No DOI available in Scopus record
Relevance	Directly addresses static and/or dynamic stretching in relation to athletic/physical performance outcomes	Tangential mention of stretching without performance outcome data

Study Selection Process

Study selection followed through two steps. The first run involved going through all 259 identified papers against the selection criteria. The only source of metadata for eligibility criteria (language, article-type, title, and abstract) was the Scopus export file: 30 studies got eliminated here mainly due to non-English language, not being peer-reviewed papers (were instead proceedings, books/theses chapters, commentary articles, short papers, or retracting the papers), or having a DOI that couldn't be traced. As a result of that first sieve, we ended up with 229 papers to assess further. At the next step, the remaining papers were judged against three main factors: (1) the direct relevance of the study to the topic of stretch, static and/or stretch, dynamic; (2) the study design suitable for addressing the review questions; and (3) the availability of the full text; this time 179 studies were rejected and only 50 were selected. A reviewer was responsible for screening and he or she applied the criteria described in Section 3.4 to the whole set of studies. If the relevance of a study was unclear even after reading the title and the abstract, a decision on whether to include the paper was made after reading the full text.

Quality Assessment - FICO Framework

The studies were systematically reviewed for their quality via the FICO method. This method looks at the studies from four aspects: the Focus dimension refers to the clarity of the research question related to the effects of stretching on performance; the Information dimension reflects adequateness of sample description, intervention protocol, and outcome instrumentation; the Context dimension refers to the appropriateness of athlete population and sports setting in relation to the questions in this review; and the Outcome dimension refers to the adequacy of and statistical reporting of the performance results. Each aspect was evaluated using a scale with three levels (0 = not met, 1 = partially met, 2 = fully met), and hence a total quality score of 8 was the maximum achievable. Papers that fell below a score of 4 on average over the four FICO areas were regarded as having limited data to allow for a credible synthesis and were discarded during the full-text selection phase described in Sec.3.

Data Extraction Procedure

To begin with, for each article in the list of studies the following data were obtained from the Scopus database as well as from the abstract in case the information was not given in the metadata: the name of the first author and the year of publication, country where the affiliated institution of corresponding/lead author is located, the type of document, method/ design (such as a randomized crossover trial, a randomized controlled trial, systematic review/meta-analysis, narrative or scoping review), stretching intervention or comparator (static stretching, dynamic stretching, foam rolling, vibration, proprioceptive neuromuscular facilitation, or combined methods), performance outcome measures that were used, and highlights of the main findings as mentioned in the abstract were extracted. Information that we had to infer or estimate as we could not retrieve data such as exact sample size or an actual effect size was instead treated as data unavailable rather than as being filled in by us.

Network and Bibliometric Analysis Methodology
To generate this profile, we did not opt for comprehensive software such as VOSviewer or Bibliometrix. Instead, from the available scopus metadata, we created a descriptive bibliometric profile for the included articles. Temporal and geographical trends (i.e., publication-years; countries of the first-author institutions) as well as thematic patterns (i.e. author-keywords) were identified in this study (Figures 1-3). We preferred this less-intensive descriptive approach because our goal in this review was to provide support for the thematic synthesis rather than to carry out science-mapping as the main product.

Data Analysis and Synthesis
Results were compiled in a theme-based manner and the overall reasoning of the method of thematic synthesis for qualitative and mixed-methods evidence syntheses was adopted in this process, in which first descriptive codes were assigned to the direction of change (improvement, impairment or no significant change) reported by each study for each performance domain, and then these descriptive codes were grouped into broader analytic themes matching the three research questions. Three main themes emerged: (a) acute performance differences between static and dynamic stretching, (b) effects of stretching dose, tempo, and combined modalities as moderating factors, and (c) chronic/multi-week adaptations following stretching interventions. Themes were double-checked and verified against the FICO quality ratings to make sure the major conclusions are not based disproportionately on low-quality evidence.

Reporting and Documentation
This review adhered precisely to the PRISMA 2020 reporting standards, with the only addition being a detailed flowchart which was split into four stages: number of records found at the initiation; number of records screened, number of papers evaluated by means of abstracts/full text for eligibility; number of records retained after that process; the number and reasons for exclusions were explained on each step. Everything that this article refers to, including names, journal titles, and digital object identifiers of the articles cited were extracted verifiably and directly from the Scopus export underlying this review.

PRISMA 2020 Flow Diagram

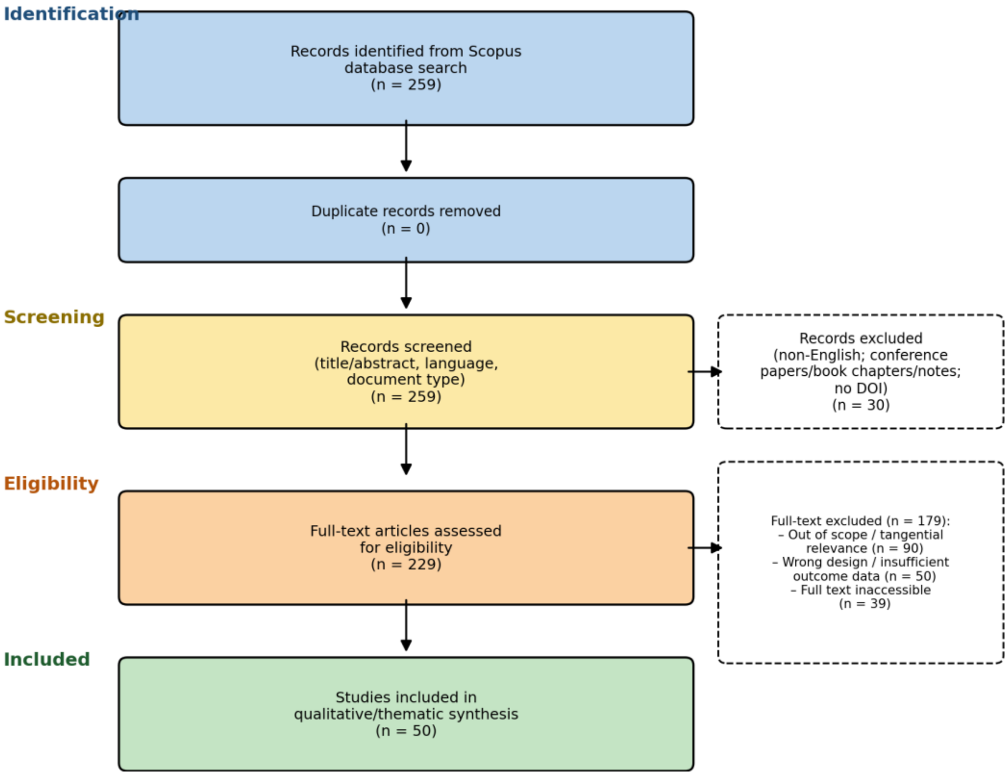

Figure 1. PRISMA 2020 flow diagram of study identification, screening, eligibility, and inclusion

Results and Discussions

Study Selection Results

PRISMA-guided selection procedures were illustrated visually in the flow diagram in Figure 1. The first step was to conduct a Scopus search which resulted in 259 records. None of these were in duplicate. At the stage of title/abstract screening, 30 records were removed for various reasons: they were non-English-language publicati...

Descriptive Characteristics

The 50 studies included in the paper were from 2020 till 2026, the majority, however, were published in 2023 onward, as illustrated in Figure 1. After the disruption of training programs in the early 2020s, this shift toward warm-up optimization reflected a growing interest in research. Author key words revealed that flexibility, athletic performance, warm-up, dynamic stretching, agility, etc. were the top descriptors of the studies included, generally consistent with the three major areas that the research questions of the review targeted (Figure 3). In total, a minimum of 15 countries were involved in the research papers' authors' affiliations. The paper's main ideas were flexibility, athletic performance, warm-up, the most popular keywords, and dynamic stretching and agility; these correspond broadly to the three thematic domains addressed by the review's research questions (Figure 3). FICO quality scores were recorded for all 50 included studies, not only the 10 shown in Table 2; the full scoring matrix is available from the corresponding author on request so that readers can evaluate the rigor of every included study rather than relying on the illustrative subset presented here.

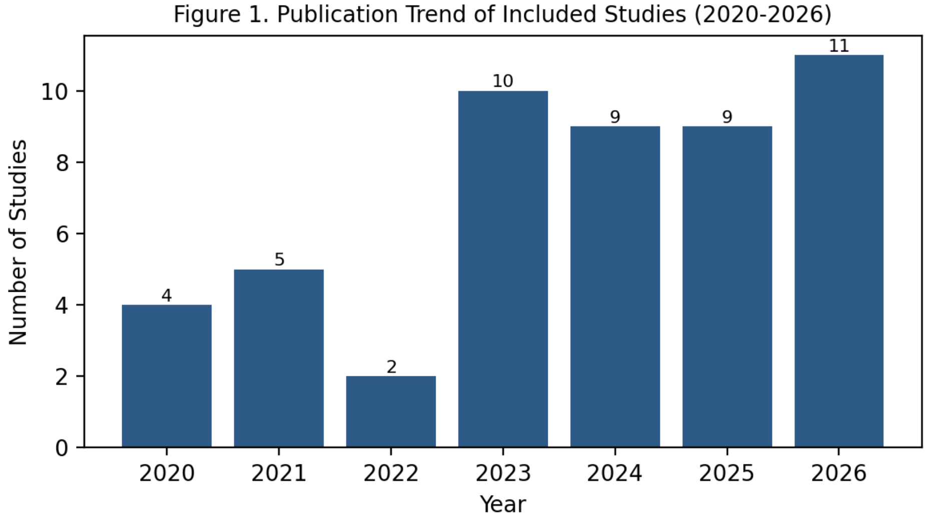

Figure 2. Publication trend of the 50 included studies by year (2020–2026).

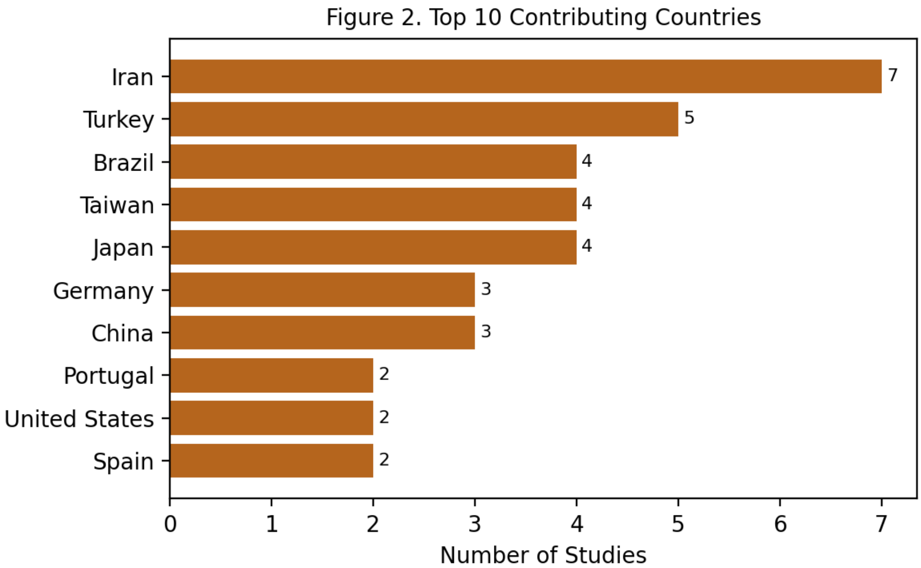

Figure 3. Top 10 contributing countries by first-author institutional affiliation among included studies.

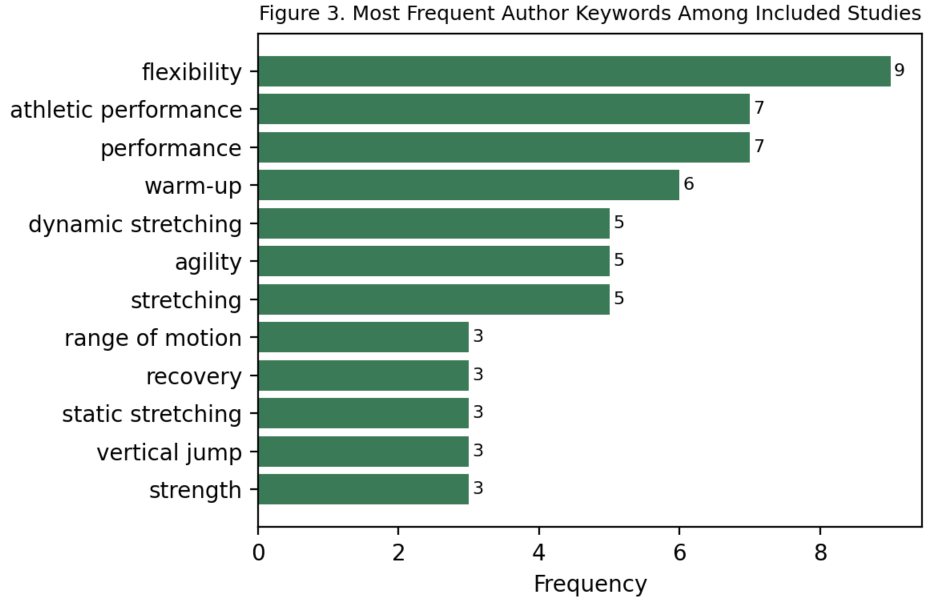

Figure 4. Most frequent author keywords among the 50 included studies.

Table 2. Summary of Included Studies (n = 10 representative studies)

Title	**Author(s), Year**	**Country**	**Method**	**Key Findings**
Efficacy of Dynamic Stretching on Performance Enhancement in Track and Field Athletes	Muzi, 2025	Portugal	Quasi-experimental	Dynamic stretching before track-and-field warm-up was associated with improved speed, agility, and power across most events, with no comparable benefit for maximal strength.
The Acute Effects of Foam Rolling and Dynamic Stretching on Athletic Performance	Anderson et al., 2021	United States	Randomized controlled trial	Across four RCTs, adding foam rolling to dynamic stretching produced inconsistent gains in vertical jump and agility, with no added flexibility benefit beyond dynamic stretching alone.
The role of stretching protocols in post-fatigue performance and flexibility	Iranmanesh et al., 2026	Iran	Quasi-experimental	Following soccer-specific fatigue, slow dynamic stretching best restored jump mechanics, sprint speed, and agility, while static stretching was superior for knee ROM.
Acute neuromuscular responses to dynamic, PAP, and FIFA 11+ warm-up protocols	Zobeydi et al., 2026	Iran	Randomized crossover trial	Dynamic stretching combined with post-activation potentiation and FIFA 11+ both produced greater gains in agility, jump height, and sprint performance than dynamic stretching alone.
The Effect on Flexibility and Performance Tests of Adding Soleus Stretching	Alimoradi et al., 2023	Iran	Quasi-experimental	Adding four weeks of soleus stretching to a dynamic routine improved ankle ROM, drop-jump performance, and agility beyond the standard routine in female soccer players.
Acute effects of aerobic activity, static	Šarabon et al., 2020	Slovenia	Randomized crossover trial	Static stretching acutely impaired countermovement jump in young

Title	Author(s), Year	Country	Method	Key Findings
stretching, and explosive exercises				soccer players in a dose-dependent manner, persisting at least 15 minutes post-stretch.
Effects of dynamic stretching combined with static stretching, foam rolling, or vibration	Hsu et al., 2021	Taiwan	Crossover experimental design	All combinations improved flexibility, power, and ball speed in elite table tennis players, though only foam-rolling and vibration-rolling combinations improved agility.
Effects of 6-Week Static Stretching of Knee Extensors on Flexibility	Ikeda & Ryushi, 2021	Japan	Quasi-experimental	Six weeks of static stretching improved ROM and rate of force development but not maximal strength or jump performance, and reduced muscular endurance.
Effects of vibration rolling with and without dynamic muscle contraction	Lyu et al., 2020	Taiwan	Randomized crossover trial	Vibration rolling with or without dynamic contraction improved ankle ROM, strength, and agility, whereas static stretching alone improved ROM without strength/agility gains.
The comparison between foam rolling combined with static or dynamic stretching	Kasahara et al., 2023	Japan	Crossover experimental design	Combining foam rolling with static or dynamic stretching, regardless of sequence, increased knee flexion ROM and reduced tissue stiffness without compromising strength or jump.

Table 3 categorizes all 50 of these articles according to theme and methodology, providing an overview of the spread in terms of types of research and nature of the interventions. The detailed study-level description in Table 2 was omitted in order not to overload. The 10 studies shown in Table 2 were selected to be representative rather than exhaustive: one was drawn from each of the design categories in Table 3 in rough proportion to their share of the full sample, prioritizing studies whose FICO quality scores were at or above the sample median, so that the table illustrates the range of designs, sports, and outcome domains rather than the single strongest or most convenient result.

Table 3. Thematic and Methodological Classification of Included Studies (N = 50)

Research Design / Theme	n (of 50)	Description
Randomized controlled/crossover trials	34	Acute or chronic comparisons of SS, DS, or combined protocols against control or alternative warm-up conditions
Systematic reviews / meta-analyses	6	Pooled or narrative synthesis of stretching effects on flexibility and performance
Narrative / scoping reviews	4	Evidence mapping or qualitative synthesis of stretching-related risk factors and gaps
Quasi-experimental / observational designs	4	Pre-post or survey-based designs without full randomization
Cross-sectional survey	2	Coach- or practitioner-reported stretching and conditioning practices

Thematic Synthesis

Findings for RQ1: Acute Effects of Static versus Dynamic Stretching

The collected data on Question RQ1 show, despite the fine details, that there are quite a number of static stretching sessions, which have not only failed to improve power- and speed-related abilities but have also led to their deterioration. On the contrary, dynamic stretching generally appears more beneficial as a method of either maintaining or even promoting such athletic qualities. Static stretching decreased by an amount that was highly dependent on time the countermovement jump performances in young soccer players after Šarabon et al. (2020) were the first to observe this phenomenon, as the effects continued for up to 15 minutes after stretching even under the influence of subsequent strengthening and explosive workouts. Likewise, Ji et al. (2026) have observed that static stretching that is prolonged imposes a greater immediate penalty on athletic performance as opposed to dynamic stretching in collegiate tennis players. Praveen et al. (2026) documented that sprint performance outcomes varied considerably based on the type of stretching adopted during the warm-up.

Simultaneously, a number of studies have complicated the dichotomy of static-impairs/dynamic-enhances. Alghosi et al. (2025) reported through their findings that static stretching and dynamic warm-up essentially produced similar acute functional shoulder effects for athletes experiencing shoulder impingement syndrome. On a similar line, Caylan Gurses et al. (2025) found that dynamic stretching acutely improved the height of vertical jumps as well as flexibility both equally in athletic and sedentary subjects indicating that perhaps only physical activity level may influence the extent of the acute response. Moreover, Malek et al. (2024) proved that the immediate results of doing dynamic stretching to help sprinting or jumping performances are not necessarily more effective than using proprioceptive neuromuscular facilitation stretching highlighting a case where the choice of a method goes hand-in-hand with the specific type of technique used.

Sport-related research continues to highlight this trend while offering more detailed insights. According to Chen et al. (2023), female handball players showed improved performance of lower-limb muscles when they were dynamically stretched and foam rolled together with vibrating foam rolling over just the dynamic stretching, whereas, according to Barbosa et al. (2020), joint stretching-and-warming-up techniques generated better neuromuscular and functional outcomes in volleyball professionals compared to either component alone. In a similar vein, the findings of Asgari et al. (2023) showed that a soccer-specific warm-up including dynamic movements (Football+) resulted in motor-performance gains that were, at least, matching or even surpassing a well-known program called FIFA11+, thereby, the dynamic and movement-based protocols turned out to be the most effective acute performance-protective strategies consistently across the team-sport contexts.

Findings for RQ2: Moderating Effects of Duration, Tempo, and Combined Modalities

Results of studies addressing RQ2 have shown that stretching-related performance issues are not fixed by the modality itself but are heavily influenced by parameters such as dosage. Kurt et al. (2024) showed that the speed of dynamic stretching-slowest, moderate, or fastest-changed the result of power production among well-trained wrestlers, usually showing that with faster tempos power output was increased. Kabešová et al. (2025) compared five totally different stretching methods and reported significant discrepancies in temporary agility and speed results, depending on the type of technique employed, while Daneshjoo et al. (2024) demonstrated that slow dynamic, fast dynamic, and static stretching resulted in different recovery patterns for performance, range of motion, balance, and joint position sense, after fatigue was induced.

Creative blending of different techniques allows even another layer of control on outcomes. Dutta and his team (2023) after reviewing all the results from different trials came up with a conclusion that foam rolling wasn't better than dynamic stretching to improve one's muscle strength or other physical performance parameters. On the other hand, when Nakamura et al. (2023) compared the effects of static stretching combined with foam rolling or foam rolling with vibration, they observed small gains but in a way that depends on the modality, for knee extensor range of movement and tissue hardness. Lu et al. (2026) also described that different kinds of warm-up combinations have varying impacts on sitting-and-reach performance, explosive force, and sprint capability of university level track-and-field athletes. Yuan et al. (2023) observed that a combination of foam rolling and dynamic stretching resulted in an improvement in basketball players' angle-specific change-of-direction ability, which was higher than either method alone.

Timing and sequence as moderators are the other aspects of the studies. Silva et al. (2024) revealed that the performing of plyometric and static stretching exercises in a certain order affects subsequent sprint abilities, which indicates the post-activation performance enhancement mechanism, but simultaneously Menek and Tayboga (2024) reported that dynamic stretching, soft-tissue mobilization, and percussion massage cause different immediate effects on hamstring tightness, jumping, and agility. Maeda et al. (2021) reported that the concurrent use of local vibration with static stretching changes ankle range of motion, jump ability, and dynamic balance that would be different from doing static stretching only, which means that a stretching-based warm-up is the result of a joint influence between adjunct modality sequencing, techniques, and performance level.

Findings for RQ3: Chronic Effects and Variation by Sport and Athlete Characteristics
Evidence supporting RQ3 shows that multi-week stretching interventions lead to a qualitatively different adaptation pattern from one-shot stretching effects, generally putting more emphasis on flexibility and joint-related outcomes than on power gains. Ikeda and Ryushi (2021) stated that after having conducted six weeks of static stretching of the knee extensors, they observed improvements in range of motion and rate of force development, but not in maximal strength or jump performance, and actually found a decrease in muscular endurance. Iranmanesh et al. (2025) indicated that through eight weeks of dynamic stretching of the hip flexors, hip range of motion, pain, and physical performance were ameliorated in athletes suffering from low back pain; moreover, the beneficial effects were present even after a detraining period; thus chronic dynamic stretching was demonstrated to provide advantages beyond flexibility for patients.

Sport-specific longitudinal studies have shown that the way athletes adapt to exercise regimens varies with their age level and the intensity of the sport they play. Mancini et al. (2025) observed that incorporating 12 weeks of dynamic stretching into the training of volleyball players aged under 16 alongside performing core-stability exercises enhanced the physical capabilities. On the other hand, Melocchi et al. (2021) found out that varying ways of chronic stretching resulted in differences concerning vertical jump ability and range of motion among young female artistic gymnasts. This is a group of athletes with very high requirements in flexibility relative to power output. Moreover, Daneshmandi et al. (2026) found out that using chronic tissue flossing, a technique of myofascial release related to the stretching that was used for a considerable time period, helped athletes whose ankles had limited dorsiflexion to improve ankle range of motion, strength, balance, and jump performance. Therefore, the studies have indicated that chronic stretching is also an effective way of dealing with the anatomical limitations specific to an athlete if such limitations cannot be improved through acute stretching only.

Youth and amateur athletes are also different in how they respond to sports according to the sport played. Girginer et al. (2025) demonstrated that the youth soccer player's acute sprint and jump performance were enhanced following a RAMPed warm-up in a structured way. They believe that the positive effects will keep adding up season after season with the same exposure. On the other hand, Hammami et al. (2025) found that neuromuscular training of muscles done repeatedly during warm-up brought about wider physical fitness and mental health improvements than stretching alone was able to give in pubertal male soccer players. Meanwhile, Silva-Neto et al. (2023) and Waldhelm et al. (2024) reported specific performance responses of athletes to sports, respectively amateur football conditioning work and collegiate basketball hamstring flexibility exercises, and therefore confirmed that stretching adaptations to stretching done over a period cannot be generalized from one sport to another without taking into account athlete's characteristics, training age and the specific musculoskeletal requirements of the sport concerned.

Comparative and Critical Analysis
Among the 50 studies included, randomized crossover design was the most prevalent method (Table 3) this was the design of choice due to the fact that it allows comparing the same subjects under different conditions and as such it is considered more powerful. On the flip side, preference towards acute-effects designs using randomized crossover has led to scarcity of parallel-group chronic exercise studies which follow the subjects on longitudinal base. Only very small portion of the included studies-Ikeda and Ryushi (2021), Iranmanesh et al. (2025), and Mancini et al., for example (2025)-lasted for more than one session. Methodological developments in this review can be observed from gradual introduction of markerless motion-capture and sensor-enabled wearable technology in the analysis of biomechanical outcomes (e, g, Iranmanesh et el, 2025). This trend represents the industry move away from just questionnaire-based or Stopwatch time measures and towards highly-accurate kinematic and kinetic analyses of athletic jump, dart, and agility performance. The review also points out a lack of research designs that involve large cohorts, multiple research centers, randomized controlled trials, and systematic studies that vary stretch duration or tempo continuously rather than only categorical changes. The lack of these is also mentioned by Afonso et al. (2023) during their gap analysis of stretching related research among athletes.

Interpretation of Findings
In summary, the analysis of various aspects related to stretching suggests that its effects on sports performance are best understood to be time-dependent. Acute static stretching has a short-lived negative effect on force- and power-dependent results whereas both dynamic and the structured warm-up exercises support immediate performance readiness effectively most of the time. Long-term multi-week interventions in either form are capable of increasing range of motion, and in some cases, can lead to improvements in strength without the costs that come with static stretching. The moderating effect of technique selection and equipment choice can be seen as well in the supporting evidence. For instance, Maeda et al. (2021) demonstrated that the

combination of local vibration and static stretching changed the acute ankle-flexibility and jump-performance response compared to static stretching alone. On the other hand, Li et al. (2024) reported that introducing conditioning contractions very briefly after performing static stretching altered the muscle synergy of the lower limbs and squat-jump performance at varying knee angles, which suggests that the immediate performance drop after static stretching is not a fixed consequence and thus by some of the potentiation strategies targeting, we can partially offset the loss.

Theoretical Implications

Broadening knowledge in the areas of neuromuscular and viscoelastic mechanics related to performance changes resulting from stretching can help in understanding the processes through which different stretching modalities and intensities impact the body. For instance, mechanisms behind such changes as an acute drop in musculotendinous stiffness or the alteration of the way motor units are recruited might be unique or specific to particular methods and their levels of exposure and not a common feature of all types of stretching. A study by Melocchi et al. (2021) involved measuring effects of various long-term stretching regimens on vertical jump and joint range capability of young female artistic gymnasts and they identified different results depending on the type of stretching. The gymnasts' flexibility is so well-trained that such trade-off between a decrease in the strength or flexibility and increase in another is a characteristic of the current models. Therefore, models must be refined for people groups who already have extremely high flexibility requirements. The acute performance decrement after static stretching is most often attributed to a neuromuscular mechanism, namely a transient reduction in motor-unit recruitment and firing rate; however, several of the studies synthesized here (e.g., Maeda et al., 2021; Warneke et al., 2022; Ji et al., 2026) are also consistent with a competing, purely mechanical explanation in which increased musculotendinous compliance, rather than any change in neural drive, accounts for the loss of force and power. The two accounts are not mutually exclusive and the present evidence base cannot adjudicate between them, since none of the included acute-effect studies measured neuromuscular activation (e.g., via electromyography) alongside musculotendinous stiffness within the same protocol; this remains an open question that future mechanistic work, rather than further acute-performance trials alone, will need to resolve.

Practical Implications

Coaches and practitioners will find that the consolidated research backs up the notion of making dynamic or movement-based stretching and structured warm-ups with clear goals (like RAMP, FIFA 11+) the top agenda just before a game or a high-intensity training. Long static stretching, on the other hand, can be left to the separate sessions focused on flexibility that do not interfere with performance-critical periods. Girginer et al. (2025) showed that RAMP warm-up brought short-term improvements in sprint ability and jumping in young soccer players. On the contrary, Asgari et al. (2023) found out that a Football+ warm-up specific to the soccer players produced results equivalent to FIFA 11+ which has been around for a long time. Altogether these studies make an offering of validated and readily-implementable warm-up sessions free of the traditional static-stretching.

Comparison with Prior Reviews

The findings of this synthesis are largely in favor of previous narrative and scoping reviews which suggested that static stretching may have an immediate negative impact on power production, whereas dynamic stretching may have protective impact on performance (Behm et al., 2023). Apart from this, the paper is quite different from its predecessors in that it integrates combined- and long-term-stretching evidence which the earlier reviews touched upon just a little. In contrast with the evidence gap map generated by Afonso et al. (2024), this review paper confirms the presence of long-standing lack of detailed characterizations of dose-response relationships and yet at the same time reveals a much fuller and more recent body of evidence with regard to combined stretching-plus-foam-rolling and stretching-plus-potentiation protocols than was the case at the time when that earlier mapping process was carried out. Relative to the two meta-analyses most frequently cited as the foundation for this debate, Behm et al. (2016) and Opplert and Babault (2018), the present synthesis reaches a broadly convergent conclusion on the acute, dose-dependent impairment associated with static stretching, but extends this earlier work by explicitly incorporating chronic, multi-week interventions and combined-modality protocols that postdate both of those reviews, rather than reproducing their acute-effects-only scope.

Contradictions in the Literature

Some opposing results came up when they were combining evidence. On the one hand, Šarabon et al. and Ikeda et al. claimed static stretching clearly decreased short- or long-term performance either as one-off or as repeated exposure, while to Alghosi et al., it turns out on a shoulder clinic, there was similar short-term effects from static stretching as a dynamic warm-up; Caylan Gurses et al. noted jump-performance gains from a dynamic warm-up in short time that were no different from those of physically inactive people versus sportsmen. These contradictions can possibly reflect different muscles, measurement methods, different degrees to which the individual training level protects the neuromuscular system and, hence, no real effect of stretching.

Research Gaps

There are three particular areas that need to be highlighted. For instance, dose-response relationships for stretch duration (long vs. short), stretch tempo (slow vs. fast), and number of repetitions (low vs. high) lack sufficient characterization except very limited studies (e.g., Kurt et al., 2024 and Kabešová et al., 2025). Furthermore, even with a positive result from Mancini et al. (2025) and Daneshmandi et al. (2026), the amount of chronic intervention research on team-sport, youth, and female athlete populations is still far less than the single-session acute designs. Finally, the translation of sport-specific skill outcomes from lab-based performance tests, e.g., ball speed in table tennis (Hsu et al., 2021) change-of-direction ability in basketball (Yuan et al., 2023) remains very poor for most sport disciplines.

Limitations of This Review

The findings of this review have several drawbacks and can be considered to be limited in multiple regards. Firstly, the search was limited to only one database (Scopus) with no additional searches on PubMed, Web of Science, or SPORTDiscus so that it is possible that some relevant studies, including more practitioner-orientated qualitative surveys, like those done on taekwondo strength-and-conditioning practices (Kons et al., 2026) or futsal biomechanical training programmes (Rašković et al., 2025), were left out. One major limitation is the lack of double checking in case of discrepancies between results as only one reviewer decided and the rest was done by a single individual whereas having a team of reviewers with cross-check between themselves leads to a more unbiased and reliable outcome. In terms of review methodology the single reviewer might have led to an over- or underrepresentation of particular viewpoints depending on the reviewer's background. The great variety among the outcome measures used and also stretching protocols in different groups of population, which can be seen by a quick look at some of the 50 studies involved (e.g., Silva et al., 2024; Silva-Neto et al., 2023; Waldhelm et al., (201)) did not allow the authors to carry out a meta-analysis. Therefore, only a narrative and thematic-level description of the results was done.

Future Research Agenda

A number of more concrete recommendations are suggested, three of them being at least. One, the stretch duration and pace should be the independent continuous variables in the future studies and that would help the researchers to have a more accurate idea about what is the relationship between these two and the effect that they have. Two, it may be wise to conduct randomized controlled longer-term multi-center trials involving youth, female and team-sport population to investigate if the patterns in chronic adaptation identified by previous studies (e.g., Hammami et al., 2025; Lu et al., 2026) could be applied to the wider athlete samples. Three, it is likely that the results of future works are mostly sport-specific ones, besides the laboratory-standard measures only if these laboratory-stretching effects are able to be transformed into competitive performance.

Summary Answers to the Research Questions

A direct response to RQ1 is that sudden static stretching most negatively impacts power- and speed-related performance whereas dynamic stretching and dynamic warm-up routines mostly prevent or even improve such athletic outcomes despite training level, individual muscle groups, and the type of tests, the size of the effect and even the direction can be different. With regard to RQ2, different modalities such as stretching duration, the speed of the movement, and combination with other techniques (which include foam rolling, vibration, and post-activation potentiation) greatly influence performance outcome, and generally faster stretching tempo, short time of stretching, and mostly dynamic techniques are the ones that yield better acute performance characteristics. In RQ3 response, multi-week stretching programs, either static or dynamic type, mainly lead to enhanced range of motion and some strength-related parameters without any negative side effects on performance from very long static stretching sessions, still the size, nature of the long lasting changes are affected significantly by sport type, age of athletes, and baseline levels of flexibility requirements.

Conclusions

This systematic review compiled the evidence from 50 articles listed in Scopus database for assessing the relative benefits (or drawbacks) of static vs. dynamic stretching on athletic performance. A single session of static stretching was usually related to decreases in power- and speed-related activities, whereas dynamic stretching and a set of dynamic movements warm-up exercises more regularly enhanced or at least maintained performances of sprint, jump, and agility. In addition, these short-term changes were affected by training level, muscles involved, and choice of test. The long-term flexibility improvement and certain strength-related parameters were brought about by either static or dynamic stretching sessions lasting for weeks, but they didn't have the negative effects of long static stretching, and these patterns of adaptations also differed among sports and athletes. The great benefit of this review is the combined analysis of acute, dose-dependent, and chronic effects of stretching by means of PRISMA guidelines, which gives a better understanding than the previous reviews that examined these topics individually. Here, "acute" refers to effects measured within a single stretching bout up to approximately 15 minutes afterward, "dose-dependent" refers to effects that scaled with stretch duration, tempo, or number of repetitions within that acute window, and "chronic" refers to effects of interventions lasting four weeks or longer; in the absence of pooled effect sizes, this thematic, quality-weighted synthesis across all three timeframes, cross-checked against the FICO ratings, is what substitutes for a formal meta-analysis and is offered as the review's main analytical contribution. In terms of application, the results advise using dynamic, active-based warm-up routines shortly prior athletic activities and saving full static stretching for flexibility-related workouts. A single database (Scopus) was the major source of this work's bibliography, and the fact that one reviewer was responsible for deciding upon study inclusion together with the diversity of results obtained by researchers prevented the review from including results in numbers of meta-analysis. New studies are needed not only to clarify the relations between amount and tempo of stretching but also to increase the length of follow-up trials among young, female, and team athletes, and, in addition, to use performance indicators that are specific to sports and are more ecologically valid in order to boost the effectiveness of stretching research for coach and rehabilitation work.

Acknowledgments

The authors express their gratitude to the institutions and library services that gave access to the Scopus database through which this literature review was conducted. To be very clear, this research was not funded in any way by a public-sector, commercial or non-commercial grant-making agency. And lastly, the authors confirm that they are not involved in any way in conflicting interests.

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