The Effect of Static Stretching Before Exercise on Physical Performance: A Literature Review

Pengaruh Stretching Statis Sebelum Latihan terhadap Performa Fisik

Review Article

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Abstract.

Background Various studies have explored the effects of static stretching on physical performance, but the results are still mixed. Some studies indicate that static stretching can decrease several aspects of performance such as speed, agility, and balance, while others have found that static stretching can increase muscle torque and movement economy in endurance activities.

Objectives Therefore, this study aims to review the scientific literature regarding the effect of static stretching before exercise on physical performance.

Methods The literature search was conducted using the Harzing Publish or Perish application following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. After applying exclusion criteria, only nine articles met the criteria and are described further.

Results The results indicate that static stretching before exercise can have a positive impact on muscle torque and movement economy, but is less beneficial for sports that require speed and rapid changes of direction. The effects of static stretching are highly dependent on the duration, intensity, and type of exercise performed afterward. Therefore, the choice of warm-up method must be tailored to the specific needs of the individual or the sport being pursued

Conclusion Some limitations in this review include the limited number of studies and methodological variations in the studies analyzed. Further studies using meta-analysis and literature mapping (bibliometric and scientometric) approaches are needed to understand research trends in this field and develop recommendations based on scientific evidence regarding the application of static extension in various sports.

Keywords: Static Stretching, Physical Performance, Warm-Up Before Exercise.

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INTRODUCTION

Static stretching has long been an integral part of physical activity or exercise [1] . This stretching method involves holding a specific position for a specific amount of time to achieve its benefits [2]. Static stretching can improve flexibility, reduce the risk of injury, and enhance physical performance [3]. Therefore, many coaches and sports practitioners recommend static stretching because of its various benefits. However, several recent studies have provided new insights regarding static stretching before exercise. Some of these studies indicate that static stretching before exercise can reduce performance, particularly in activities that require strength, speed, and explosive power [4]. Although numerous studies have provided results related to static stretching on physical performance, there are still varying opinions regarding the extent of this effect in individuals who are accustomed to and physically active [5].

Warming up or stretching comes in several forms, such as static stretching, dynamic stretching, and proprioceptive neuromuscular facilitation (PNF). Several studies have shown the effects of static stretching on performance, including "stretch-induced strength loss," which reduces muscle contraction and strength and explosive power [6]_. Meanwhile, other studies suggest that the impact of static stretching depends on the duration and type of exercise performed [7]_. These differences in findings raise questions among sports practitioners about whether static stretching should be performed before exercise or whether other stretching methods, such as dynamic stretching and activity-based warm-ups, are available.

Static stretching involves holding a specific position for 15 to 60 seconds [8] . In contrast, dynamic stretching utilizes momentum to activate muscles [9]. Research has shown that prolonged static stretching can affect muscle and tendon properties [10]. Furthermore, several studies have shown that prolonged static stretching can reduce muscle stiffness, which contributes to explosive power [11]. Therefore, this study provides and compiles the latest research based on existing scientific evidence. It presents the latest findings from biomechanics, physiology, and muscle anatomy to evaluate and assess individual performance, particularly in strength, speed, and explosive power.

The effect of warming up on performance has been proven in several studies. Performance is an indicator of strength, speed, and explosive power [12] . Achieving good performance is inseparable from joint mobility [13]. Therefore, the status of joint hyper- or hypomobility is crucial to consider [14]. There is a consistent correlation between changes produced by stretching and improved performance and a reduced risk of injury [15].

Therefore, analyzing and reviewing various other studies is important. This is expected to provide a clearer view and evidence regarding optimal warm-up strategies before starting a sporting activity [16]. However, many studies discussing the effects of static stretching on performance are heterogeneous in terms of duration, intensity, and stretching method, making it difficult to draw conclusions. Therefore, this study attempts to identify several relevant findings and evaluate them in relation to physical performance. This research is also expected to provide input and insights for coaches, athletes, and other sports practitioners to support optimal performance.

METHOD

Search Strategy

Research data was searched using the Harzing Publish or Perish application. The keywords used to conduct the search were ("static stretching" OR "pre-exercise stretching" AND "performance". This aims to determine the effect of static stretching before exercise on physical performance. The search strategy was based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. PRISMA guidelines can ensure systematic and transparent results. Next, the author will select the characteristics of the study and the research methodology.

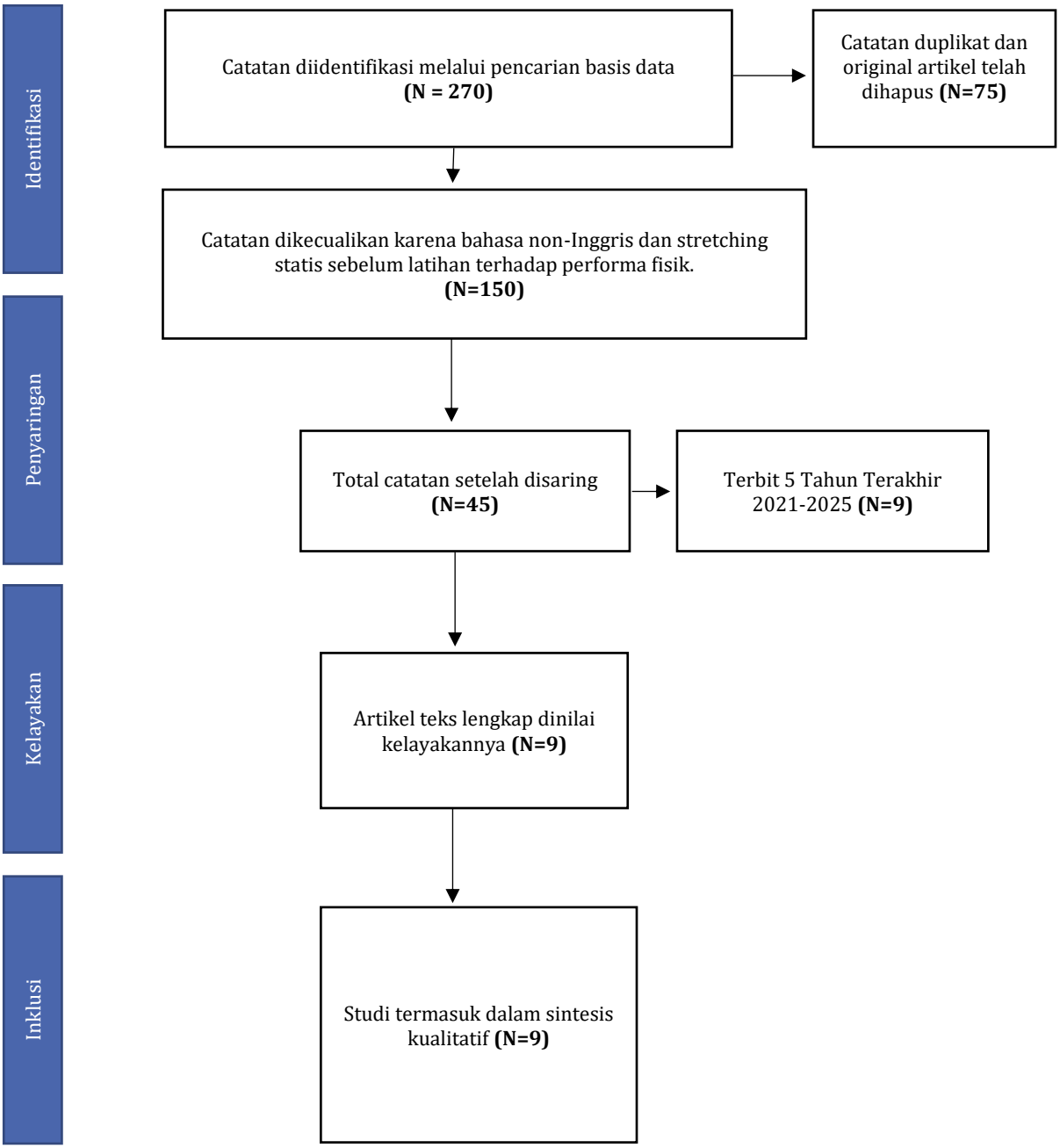
Exclusion Criteria

The exclusion criteria used were as follows: (1) Articles in the form of literature reviews, (2) Articles in languages other than English, (3) Articles published outside the last 5 years, namely 2021-2025. (4) Articles that do not explicitly mention the effect of static stretching before exercise on physical performance.

Procedure

The initial search identified 270 articles from various databases. After screening, 75 articles were found to be duplicates. Title and abstract identification yielded 150 articles that did not meet the research criteria. Exclusion criteria were applied, leaving 36 articles out of 45 after the initial screening process. Nine articles remained eligible for further analysis.

Figure 1. PRISMA Research Flowchart



RESULTS AND DISCUSSION

The five categories (Author and Year excluded) listed in Table 1 are described and discussed in one compiled article. The country category is not shown, as all articles focus on one country, namely Indonesia. The results can be seen in Table 1.

Table 1. Article Summary About Game Model Learning on Motor Skills

Author and Year	Research Methods and Types	Content	Research purposes	Research result
[10]	Quantitative, experimental research, with three groups (control, static stretching, and	This study compared the effects of static and dynamic stretching on	This study aimed to analyze the effect of two types of stretching on eccentric peak torque and functional	Static stretching decreased peak eccentric torque by 18% but had no significant effect on functional performance in the triple hop and 20m shuttle run tests.

	dynamic stretching)	eccentric peak torque and functional performance in active, healthy men.	performance in active and healthy men.	
[17]	A counterbalanced, experimental, randomized crossover study with 8 male runners who performed three running tests to exhaustion with static (SS), dynamic (DS), and no stretching (NS) warm-ups.	This study assessed the effects of static and dynamic stretching on the physiological, metabolic, endurance performance, and perceived effort responses of recreational runners.	To investigate the acute effects of static and dynamic stretching on physiological, metabolic responses, endurance performance, and effort perception in recreational runners.	Static and dynamic stretching improved running economy and decreased perceived effort during a run-to-exhaustion test, with no significant differences in physiological and metabolic responses between stretching sessions.
[18]	A quantitative, experimental study with a pre-test and post-test design, involving 10 healthy students, used isokinetics to measure hamstring and quadriceps strength at two contraction velocities (60 and 240˚/s).	This study examined the effects of acute stretching (static and dynamic) on hamstring and quadriceps strength, as well as their reciprocal ratio (HRQ), at two different contraction velocities.	To investigate how acute stretching (static and dynamic) affects hamstring and quadriceps muscle strength and their reciprocal ratio at different contraction velocities.	Acute stretching increased hamstring and quadriceps muscle strength at both contraction speeds ($p < 0.05$), but the reciprocal ratio (HRQ) did not change significantly ($p > 0.05$).
[19]	This quantitative, experimental study, with a randomized, balanced design, involved 32 military men undergoing an isokinetic muscle strength test at 60°/s after either a traditional warm-up protocol or a warm-up with static stretching.	This study compared the effects of including static stretching in a general warm-up on muscle strength in Brazilian military personnel, by measuring isokinetic torque in knee extension and flexion.	To compare the effects of static stretching included in a general warm-up procedure on muscle strength in Brazilian army personnel.	Adding static stretching to the warm-up increased peak isokinetic torque in knee extension and flexion, with a significant difference in the experimental group ($p < 0.05$), while the traditional group only showed a significant increase in knee extension.

[20]	This quantitative, experimental study, with a randomized design, involved 20 healthy, recreationally active men who were divided into two groups, namely dynamic stretching warm-up (DWU) and static stretching warm-up (SWU).	This study compared the effects of dynamic and static stretching warm-ups on physical performance, as measured by agility, speed, and vertical jump tests in participants who warmed up after a 10-minute jog.	To compare the effects of dynamic and static stretching warm-up on physical performance, including agility, speed, and vertical jump.	There was no significant difference between dynamic and static stretching warm-ups on physical performance in the vertical jump test (p=0.22), speed (p=0.99), and agility (p=0.24).
[21]	This quantitative, experimental study, with a pre-test and post-test design, involved 100 students aged 12-16 years who were divided into two groups: static stretching (A) and dynamic warm-up (B).	This study compared the effects of static stretching and dynamic warm-up exercises on vertical jump performance in school students, with assessments conducted before and after the intervention.	To compare the immediate effects of static stretching versus dynamic warm-up exercises on vertical jump performance in 12-16 year old students.	Both groups showed improved vertical jump performance, but the group performing dynamic warm-up exercises (B) was more effective than the static stretching group (A).
[22]	Quantitative research, A single-blinded, cross-over, randomized clinical trial, with 54 male participants divided into two groups: static stretching (A) and dynamic stretching (B).	This study compared the acute effects of static and dynamic stretching on the physical performance of non-athletes, with performance measures including endurance, agility, strength, flexibility, and balance.	To compare the acute effects of static and dynamic stretching on the physical performance of non-athletes.	Dynamic stretching significantly improved all measures of physical performance ($p<0.05$), while static stretching reduced agility and balance ($p<0.05$) in non-athletes.
[23]	Experimental research with a randomized clinical trial design, five warm-up	This study compared the effects of various stretching warm-up	To compare the effects of different stretching methods on change of direction (COD) ability in soccer players.	Dynamic stretching significantly improved COD performance ($p = 0.03–0.002$), while static stretching showed a detrimental effect on COD performance ($p < 0.01$). The control condition

	conditions, involving 12 male soccer players. The groups were divided into five warm-up conditions: (1) control (no stretching), (2) static stretching, (3) dynamic stretching, (4) combined static-dynamic stretching, (5) combined dynamic-static stretching.	methods on change of direction (COD) performance in male soccer players using the Illinois agility test.		showed no significant difference compared to dynamic stretching.
[2]	Experimental research, A crossover randomized controlled trial, with 20 athletes undergoing 4 conditions: 3 experimental conditions (normal warm-up plus static stretching of quadriceps, hamstring, gastrocnemius, and tibialis anterior for 30 seconds, 1 minute, or 3 minutes) and 1 control condition (normal warm-up).	This study evaluated the effect of different durations of lower limb static stretching on long jump (LJ) performance, measured by the distance achieved after the intervention.	To evaluate the effect of different durations of static stretching of the lower limbs on the performance of long jump athletes.	Static stretching for 3 minutes showed a significant increase in jump distance ($p = 0.012$). However, there was no significant difference between the four warm-up conditions ($p = 0.154$), indicating that the duration of static stretching did not significantly affect long jump performance.

Research Methods and Types

Based on the method category and research type, eight articles exclusively used a quantitative approach with an experimental design [10]; [18]; [19]; [20]; [21]; [22]; [23]; [2]. One article used an experimental approach with a counterbalanced randomized crossover design [17]. Most studies used a pre-test and post-test design, and some implemented a randomized clinical trial or crossover randomized controlled trial. On average, these articles used isokinetic-based measurement instruments, running to exhaustion tests, and various stretching protocols to assess the impact on physical performance.

Content

Research results show various effects of static and dynamic stretching on physical performance, such as increasing eccentric peak torque and functional performance in active men [24], as well as the effect of acute stretching on hamstring and quadriceps strength [18]. The effect of static stretching in warm-up on isokinetic torque was also studied in military personnel [19], while the duration of static stretching was studied in tanks with long jump performance [2]. Furthermore, research on endurance

performance and effort perception was conducted in recreational runners [17] as well as in non-athletes who were tested on various physical parameters, such as endurance, agility, strength, clotting, and balance [22]. The impact of warm - up on agility performance and vertical jerk was also investigated, with results showing differences between static and dynamic tension in improving physical performance [20]; [21]. Furthermore, the effects of different warm-up methods on change of direction were tested using the Illinois Agility Test in soccer players [23]. Overall, this research suggests that the type and duration of stretching can have different effects on physical performance, so the selection of stretching methods should be tailored to the needs.

Research Objectives and Results

Based on reflection on the collected research, it appears that the effects of static stretching before exercise on physical performance are still being investigated in various studies. Some studies indicate that static stretching can decrease muscle strength, agility, and balance, while others find that static stretching does not always negatively impact performance, depending on the duration, intensity, and characteristics of the individual performing it. The effects of static stretching also appear to vary depending on the type of exercise performed, whether it focuses on strength, endurance, or complex motor skills. Therefore, understanding how static stretching affects physical performance still requires further study to determine the optimal conditions for its application in warm-ups before training or competition.

Regarding muscle strength, several studies have found that static stretching before exercise can cause a decrease in power production and muscle torque. [24] found that static tension decreased peak eccentric torque slightly, although it did not significantly impact performance in the triple hop and shuttle run tests. This suggests that while muscle strength may decrease after static stretching, its impact on functional performance may be more complex and dependent on the type of activity performed. However, other studies have shown conflicting results. [19] found that static stretching incorporated into a warm-up can increase peak isokinetic torque in knee extension and flexion in Brazilian military personnel. These differences in results may be due to population factors, the tension method, and the type of strength test used. This suggests that the effect of static stretching on muscle strength may be more dependent on individual characteristics and training goals.

In terms of endurance, research by [17] showed that static stretching before running can improve running economy and decrease perceived effort without significantly affecting physiological and metabolic responses. This means that while static stretching does not directly increase physiological capacities, such as oxygen consumption or metabolic energy production, it can help runners feel more comfortable while running, potentially improving their movement efficiency. These findings suggest that for athletes who prioritize energy efficiency in endurance sports, static stretching may not have a detrimental impact. However, its effectiveness in significantly improving endurance performance still requires further investigation, especially in populations with varying fitness levels.

In terms of agility and balance, several studies have shown that static stretching before exercise tends to have negative effects. [22] found that static stretching decreased agility and balance, while dynamic stretching actually improved various aspects of physical performance in non-athletes. Similar results were found in a study by [23], which showed that static stretching had a detrimental effect on change of direction (COD) in soccer players, while dynamic stretching actually improved performance in this aspect. This indicates that static stretching may be less ideal for sports that require quick reactions, dynamic changes of direction, and high coordination. In this context, dynamic stretching appears to be more recommended than static stretching for activities that require rapid motor responses and movement precision.

In terms of performance, studies have yielded mixed results. [21] found that static stretching before exercise increased vertical jump height, but was not as effective as dynamic warm-up exercises. Meanwhile, [2] found that three minutes of static stretching increased long jump distance, although overall, no significant differences were found between the four warm-up conditions tested. Furthermore, [18] found that acute stretching increased hamstring and quadriceps strength, but did not alter the reciprocal ratio of muscle strength. Conversely, [20] compared the effects of static and dynamic stretching on physical performance and found no significant differences in agility, speed, and vertical jump. These results suggest that static stretching may still have benefits for some forms of explosive activity, depending on how it is implemented before exercise. However, when compared to other warm-

up methods such as dynamic stretching or plyometric-based explosive training, static stretching does not appear to be the most optimal method for improving jumping performance.

Although numerous studies have explored the impact of static stretching on physical performance, several limitations are noteworthy. One major factor influencing research results is variation in the duration of static stretching used, with some studies using short durations (less than 30 seconds) and others using longer durations (greater than 60 seconds). Furthermore, differences in physical performance measurement methods, study populations, and types of exercise tested may also contribute to differences in results between studies. Individual factors such as fitness level, age, and training experience can also influence how a person maintains static tension before exercise. Therefore, further research controlling for these variables is needed to provide more accurate conclusions regarding the effectiveness of static stretching in enhancing or inhibiting physical performance. With a deeper understanding, more optimal warm-up strategies can be developed for different groups of athletes and individuals with varying training needs.

CONCLUSION

This review has contributed to updating the literature on the effects of pre-exercise static stretching on physical performance. Of the nine studies described, the results indicate that static stretching can have varying effects depending on the context. Some studies report that static stretching can reduce agility, balance, and reaction speed, which is disadvantageous for sports requiring explosiveness and rapid changes of direction. However, other studies indicate that static stretching can improve muscle torque and movement economy, particularly in endurance sports such as running. These differences in results indicate that the effects of static stretching are highly dependent on the duration, intensity, and type of exercise performed afterward. Therefore, the choice of warm-up method should be tailored to the specific needs of the individual or the sport being pursued. To strengthen the existing findings, future research could expand its scope by including keywords and other databases such as Scopus and Web of Science in the search results. Furthermore, further studies using meta-analytic approaches and literature mapping (bibliometric and scientometric) are needed to understand research trends in this field and develop evidence-based recommendations for the application of static stretching in various sports and athlete ability levels.

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AUTHOR CONTRIBUTION STATEMENT

The writing of this article involved roles in devising the research concept and design, reviewing and analyzing relevant literature, and drafting the overall manuscript

CONFLICT OF INTEREST AND FUNDING

There is no conflict of interest.

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