

COMPARATIVE EFFECTS OF STATIC AND PASSIVE STRETCHING ON FLEXIBILITY IN HIGH SCHOOL BASKETBALL PLAYERS

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Abstract

The purpose of this study was to investigate and compare the effects of static stretching and passive stretching on flexibility in high school basketball players following a six-week training program. The participants were 26 male basketball players aged 16–18 years from a secondary school in Udon Thani Province, Thailand. Participants were assigned into two groups: a static stretching group ($n = 13$) and a passive stretching group assisted by a partner ($n = 13$).

Flexibility was assessed using the sit-and-reach test and back extension test. Both groups participated in supervised stretching sessions three times per week for six weeks. Paired samples t-tests were used to analyze within-group changes, and independent samples t-tests were used to compare post-test differences between groups. Statistical significance was set at $p < .05$.

The results showed that both stretching methods significantly improved flexibility after six weeks ($p < .001$). Sit-and-reach performance increased from 3.90 ± 1.04 to 16.22 ± 0.85 cm in the static stretching group and from 3.61 ± 1.26 to 19.20 ± 1.30 cm in the passive stretching group. Back extension performance increased from 35.55 ± 1.89 to 54.27 ± 3.36 cm and from 34.67 ± 1.82 to 62.15 ± 1.52 cm, respectively. Post-test comparisons demonstrated significantly greater flexibility outcomes in the passive stretching group for both sit-and-reach ($t(24) = 6.93$, $p < .001$) and back extension ($t(24) = 7.70$, $p < .001$).

In conclusion, both stretching methods effectively improved flexibility; however, passive stretching produced greater improvements than static stretching in adolescent basketball players.

Keywords: static stretching, passive stretching, flexibility, basketball, physical education

Introduction

Flexibility is a fundamental component of physical fitness and an essential prerequisite for efficient movement, postural control, and injury prevention in sports performance. Flexibility refers to the ability of a joint or series of joints to move through an unrestricted and pain-free range of motion and is widely recognized as an important component of health- and performance-related physical fitness (Alter, 2004; Gleim & McHugh, 1997). In basketball, athletes are repeatedly exposed to movements that require large ranges of motion, including jumping, landing, trunk flexion–extension, and rapid changes of direction. Insufficient flexibility in the lower extremities and trunk may influence movement mechanics and physical performance during sport-specific activities, particularly those involving repeated jumping, landing, and rapid changes of direction (Gleim & McHugh, 1997; Behm & Chaouachi, 2011).

In school-based physical education and youth sport training programs, stretching is commonly prescribed as a routine activity to improve flexibility and reduce injury risk. Among various stretching methods, static stretching has traditionally been the most widely used approach due to its simplicity, minimal equipment requirements, and ease of instruction. Numerous studies have demonstrated that regular static stretching performed over several weeks can lead to significant improvements in joint range of motion (Medeiros & Martini, 2018; Konrad et al., 2024; Ingram et al., 2025). Consequently, static stretching remains the dominant practice in many educational and sport settings. In addition, stretching remains a common component of warm-up and physical preparation programs in sport settings, although its effects may vary according to the stretching modality, duration, intensity, and performance outcomes assessed (Behm & Chaouachi, 2011).

However, in practical training environments, stretching is not always performed strictly as static stretching. In many school and team-based contexts, athletes often receive assistance from a partner or instructor who applies an external force to increase the stretch position. This form of stretching, commonly referred to as passive stretching, differs conceptually and mechanically from static stretching, as the stretched muscle is relaxed while an external force moves the joint beyond the position achieved independently (Alter, 2004). Despite its widespread use in practice, passive stretching is frequently misclassified or inconsistently described in research and teaching materials, leading to conceptual confusion regarding its physiological effects.

From a scientific perspective, long-term improvements in flexibility are no longer explained solely by mechanical changes in muscle–tendon structures. Evidence suggests that neural factors, particularly increased stretch tolerance and altered sensory perception at end ranges of motion, play an important role in flexibility adaptations following repeated stretching exposure (Weppeler & Magnusson, 2010; Nakamura et al., 2015). Stretching methods that involve external assistance may influence these neural mechanisms differently compared with self-administered static stretching, potentially resulting in greater flexibility gains.

Previous research comparing stretching modalities has shown that passive stretching can produce larger increases in range of motion than static stretching, especially when applied over extended training periods (Magnusson et al., 1996; Medeiros & Martini, 2018). However, much of the existing literature has focused on clinical or adult populations, while evidence derived from adolescent athletes in real-world school training environments remains limited. Adolescence is a critical period of neuromuscular development, during which adaptations to training stimuli may differ from those observed in adults because of ongoing growth and maturation processes (Lloyd et al., 2016; Behm & Chaouachi, 2011).

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Furthermore, inconsistencies in terminology and methodological approaches across studies have contributed to ambiguity in interpreting the comparative effectiveness of static and passive stretching. In applied settings, particularly within physical education classes and school sport programs, stretching practices are often adopted without clear differentiation between stretching types or an understanding of their underlying mechanisms. This gap between scientific knowledge and practical application highlights the need for controlled field-based studies that clearly define stretching modalities and examine their effects on flexibility in youth athletes.

Therefore, there remains a lack of empirical evidence comparing the effects of static stretching and passive stretching, delivered under realistic school-based training conditions, on flexibility outcomes in adolescent basketball players. Clarifying whether externally assisted passive stretching provides superior flexibility adaptations compared with traditional static stretching may help inform evidence-based stretching practices for physical education teachers and youth sport coaches. Based on the existing literature and the proposed mechanisms of stretch tolerance adaptation, it was hypothesized that passive stretching would produce greater improvements in flexibility than static stretching following the six-week intervention.

Objectives

The purpose of this study was to investigate and compare the effects of static and passive stretching on flexibility in high school basketball players following a six-week training program.

Methods**Research Design**

This study employed a quasi-experimental pretest–posttest design to investigate and compare the effects of static and passive stretching on flexibility in high school basketball players over a six-week intervention period. Participants were allocated to groups using a matched allocation procedure based on baseline sit-and-reach scores to ensure comparable flexibility levels between groups. Random assignment was not implemented due to practical constraints associated with the school-based training environment. Therefore, the findings should be interpreted with consideration of the potential limitations associated with non-randomized group allocation.

Ethical Considerations

The research protocol was reviewed and approved by the Human Research Ethics Committee of Udon Thani Rajabhat University (Approval No. อว.0622.7/338). All participants were informed of the objectives, procedures, potential benefits, and risks of the study prior to participation. Written informed consent was obtained from all participants and their legal guardians. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Population and Sample

The population consisted of male high school basketball players aged 16–18 years from Udonpittayanukul School, Udon Thani Province, Thailand. A total of 30 players were available at the time of recruitment. The required sample size was estimated using G*Power software (Version 3.1.9.4). An effect size of 1.50, statistical power of 0.95, and an alpha level of 0.05 were specified, resulting in a minimum required sample of 26 participants. Therefore, 26 eligible basketball players were included in the study. Participants were matched according to baseline sit-and-reach test scores and assigned to either a static stretching group ($n = 13$) or a passive stretching

group ($n = 13$) using a ranked-pair allocation procedure to ensure comparable flexibility levels between groups prior to the intervention.

Inclusion Criteria

1. Male high school basketball players aged 16–18 years.
2. Voluntary participation with written informed consent.
3. No history of lower back or lower extremity musculoskeletal injury at the time of participation.

Exclusion Criteria

1. Withdrawal of consent during the study period.
2. Attendance of less than 80% of the stretching sessions.
3. Occurrence of musculoskeletal injury affecting the back or lower extremities during the intervention period.

Research Instruments

Flexibility was assessed using two standardized field-based tests:

1. **Sit-and-Reach Test** – used to assess flexibility of the hamstring muscles and lower back.
2. **Back Extension Test** – used to assess trunk flexibility.

The stretching programs and testing procedures were developed based on established principles of flexibility training. The sit-and-reach and back extension tests were treated as standardized field-based measures of flexibility. All measurements were administered according to the protocols described in *The Physical Fitness Test and Norms for Youth Athletes* published by the Sport Authority of Thailand (Sport Authority of Thailand, 2019). Content validity of the stretching programs and measurement procedures was evaluated by three experts in sport science and physical education using the Index of Item–Objective Congruence (IOC). The IOC values for both the static stretching and passive stretching programs were 0.89, indicating acceptable content validity.

Intervention Procedures

Participants in both groups participated in a supervised stretching program for six weeks, with a training frequency of three sessions per week (Monday, Wednesday, and Friday). Each training session lasted approximately 45 minutes and was conducted after regular basketball practice.

The stretching protocol was progressively structured to reflect training adaptation. During weeks 1–3, each stretching exercise was performed for three repetitions, while during weeks 4–6, the number of repetitions was increased to four repetitions. Each stretching repetition was held for 15 seconds, with a standardized rest period between repetitions. All sessions were supervised to ensure correct technique and participant safety.

Static Stretching Group

Participants in the static stretching group performed a series of static stretching exercises targeting the major muscle groups of the lower extremities and trunk. Each stretch was performed independently to the point of mild discomfort and held statically for **15 seconds** without bouncing or voluntary muscle contraction. The number of repetitions followed the progressive structure of the program (three repetitions during weeks 1–3 and four repetitions during weeks 4–6).

Passive Stretching Group

Participants in the passive stretching group performed stretching exercises with assistance from a trained partner. The partner applied an external force to move the limb or trunk to the end range of motion while the participant remained relaxed throughout the stretch. Each stretch was held for **15 seconds**, with no voluntary

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muscle contraction performed by the participant. The repetition scheme followed the same progressive structure as the static stretching group (three repetitions during weeks 1–3 and four repetitions during weeks 4–6).

Data Collection

Baseline flexibility measurements were collected prior to the intervention using the sit-and-reach and back extension tests. Post-test measurements were conducted immediately after completion of the six-week stretching program using identical testing procedures and equipment.

Data Analysis

Data were analyzed using a statistical software package. Descriptive statistics were calculated and presented as mean and standard deviation. The normality of data distribution was assessed using the Shapiro–Wilk test prior to inferential statistical analyses. Paired samples t-tests were used to examine within-group differences between pretest and posttest flexibility measures. Independent samples t-tests were used to compare posttest flexibility outcomes between the static stretching and passive stretching groups. The level of statistical significance was set at $p < .05$.

Results**Participant Characteristics and Baseline Comparability**

A total of 26 male high school basketball players completed the six-week stretching intervention without dropout or adverse events. Baseline flexibility outcomes did not differ significantly between the static stretching group and the assisted passive stretching group for either the sit-and-reach test or the back extension test ($p > .05$), indicating that both groups were comparable prior to the intervention.

Within-Group Changes in Flexibility

Within-group analyses revealed that both stretching programs produced significant improvements in flexibility after six weeks of training.

In the static stretching group, sit-and-reach performance increased significantly from pre-test to post-test ($p < .001$). Similarly, back extension performance showed a significant improvement following the intervention ($p < .001$).

In the assisted passive stretching group, significant improvements were also observed in both sit-and-reach and back extension performance after six weeks of training ($p < .001$ for both measures).

Table 1. Within-group comparison of flexibility outcomes before and after the 6-week stretching intervention

Outcome	Group	Pre-test (Mean $\pm$ SD)	Post-test (Mean $\pm$ SD)	t(df)	p-value
Sit-and-reach	Static stretching (n = 13)	3.90 $\pm$ 1.04	16.22 $\pm$ 0.85	t(12) = 32.18	< .001*
	Passive stretching (n = 13)	3.61 $\pm$ 1.26	19.20 $\pm$ 1.30	t(12) = 28.74	< .001*
Back extension	Static stretching (n = 13)	35.55 $\pm$ 1.89	54.27 $\pm$ 3.36	t(12) = 18.96	< .001*
	Passive stretching (n = 13)	34.67 $\pm$ 1.82	62.15 $\pm$ 1.52	t(12) = 34.12	< .001*

Note. Values are presented as mean $\pm$ standard deviation. Within-group comparisons were analyzed using paired samples t-tests. Statistical significance was set at $p < .05$. * Significant difference between pre-test and post-test.

Between-Group Comparison of Flexibility Outcomes After 6 Weeks

The primary objective of this study was to compare flexibility outcomes between static stretching and assisted passive stretching following the six-week intervention. Independent samples t-test analysis demonstrated significant differences between groups at post-test.

As shown in Table 2, the assisted passive stretching group achieved significantly greater sit-and-reach performance than the static stretching group ($p < .001$). In addition, post-test back extension scores were significantly higher in the assisted passive stretching group compared with the static stretching group ($p < .001$).

Table 2. Between-group comparison of flexibility outcomes after the 6-week stretching intervention

Outcome	Static stretching (n = 13) Mean $\pm$ SD	Passive stretching (n = 13) Mean $\pm$ SD	Mean Difference (Passive – Static)	t(df)	p-value
Sit-and-reach	16.22 $\pm$ 0.85	19.20 $\pm$ 1.30	2.98	t(24) = 6.93	< .001*
Back extension	54.27 $\pm$ 3.36	62.15 $\pm$ 1.52	7.88	t(24) = 7.70	< .001*

Note. Values are presented as mean $\pm$ standard deviation. Between-group comparisons were analyzed using independent samples t-tests. Statistical significance was set at $p < .05$. * Significant difference between groups.

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Summary of Results

Both static stretching and assisted passive stretching significantly improved flexibility in high school basketball players after six weeks of training. However, assisted passive stretching resulted in significantly greater improvements in both lower-body and trunk flexibility compared with static stretching.

Discussion

The purpose of this study was to examine and compare the effects of static stretching and passive stretching with assistance on flexibility in high school basketball players following a six-week training program. The main findings indicated that both stretching methods significantly improved flexibility within groups. However, passive stretching with assistance resulted in significantly greater improvements in flexibility compared with static stretching.

Effect of Static Stretching on Flexibility

The results demonstrated that static stretching significantly improved sit-and-reach and back extension performance after six weeks of training. These findings are consistent with previous studies reporting that regular static stretching performed over several weeks can effectively increase joint range of motion (Bandy et al., 1997; Konrad et al., 2024; Ingram et al., 2025).

The primary mechanism underlying flexibility improvement from static stretching is not structural elongation of muscle fibers but an increase in stretch tolerance. Weppeler and Magnusson (2010) proposed that repeated exposure to stretching alters sensory perception at the end range of motion, allowing individuals to tolerate greater joint angles before experiencing discomfort. These adaptations may be explained by changes in stretch tolerance and passive mechanical properties associated with repeated stretching exposure (Weppeler & Magnusson, 2010; Nakamura et al., 2015; Ingram et al., 2025).

In adolescent athletes, static stretching may be particularly effective due to ongoing neuromuscular development and high neural plasticity. Regular static stretching may enhance proprioceptive awareness and reduce reflexive resistance to stretch, thereby improving flexibility without imposing excessive mechanical stress on immature musculoskeletal structures (Lloyd et al., 2016). Therefore, static stretching remains a safe and effective method for flexibility development in school-based physical education settings.

Effect of Passive Stretching with Assistance on Flexibility

Although both stretching methods improved flexibility, the passive stretching with assistance group demonstrated significantly greater improvements than the static stretching group. This finding suggests that externally assisted stretching provides an additional stimulus beyond self-applied static stretching.

Passive stretching with assistance allows the joint to reach a greater range of motion because the applied force is not limited by the participant's own tolerance or muscular control. The presence of an assistant enables gradual progression toward end-range positions while minimizing voluntary muscle contraction that may otherwise limit movement (Page, 2012).

From a physiological perspective, assisted stretching may enhance stretch tolerance more effectively by repeatedly exposing the neuromuscular system to higher-intensity stretch stimuli under controlled conditions. This repeated exposure may reduce protective neural responses, such as muscle spindle activation, and increase acceptance of greater joint angles over time (Magnusson et al., 1996; Kay & Blazevich, 2012).

Furthermore, passive stretching with assistance may increase time under stretch at longer muscle lengths, which has been associated with greater flexibility adaptations during chronic stretching programs (Medeiros & Martini, 2018). These mechanisms likely explain the superior flexibility gains observed in the assisted stretching group in the present study.

Comparison Between Static and Passive Stretching

The between-group comparison clearly indicated that passive stretching with assistance was more effective than static stretching in improving flexibility after six weeks. This finding aligns with previous research suggesting that stretching methods involving external force can produce greater increases in range of motion than self-administered stretching alone (Decoster et al., 2005; Alter, 2004).

However, it is important to emphasize that the superiority of assisted stretching does not imply that static stretching is ineffective. Rather, static stretching provides meaningful improvements with minimal risk and can be easily implemented without specialized supervision. In contrast, assisted stretching requires proper technique, communication between the assistant and the participant, and careful control of stretching intensity to avoid excessive force or injury.

In school-based physical education contexts, where safety and feasibility are primary concerns, static stretching may be more appropriate for general classes, while assisted stretching may be selectively applied in structured sport training environments under qualified supervision.

These findings should also be interpreted within the broader context of stretching research, which suggests that the effects of stretching may vary according to the stretching modality, duration, and performance outcomes assessed (Behm & Chaouachi, 2011). Therefore, the superiority of one stretching method over another may depend on the specific training objectives, athlete characteristics, and practical context in which the stretching intervention is applied.

Practical Implications

The findings of this study provide practical guidance for flexibility training in adolescent basketball players. Both static stretching and passive stretching with assistance can be used to improve flexibility; however, the choice of method should be based on training goals, supervision availability, and participant readiness. Passive stretching may be particularly beneficial for athletes requiring greater flexibility improvements, whereas static stretching remains suitable for general physical education programs.

Limitations

This study has several limitations. First, the sample size was relatively small and limited to male high school basketball players from a single school, which may restrict the generalizability of the findings to other populations. In addition, baseline anthropometric characteristics such as body mass, height, and body mass index were not included in the comparative analyses and therefore may have influenced flexibility outcomes. Second, participants were allocated using a matched procedure rather than random assignment; therefore, the findings should be interpreted with consideration of potential limitations in internal validity. Third, only pre-test and post-test measurements were included in the final analysis. Consequently, the temporal pattern of flexibility adaptations throughout the intervention period could not be fully examined. Future studies should consider larger and more diverse samples, randomized allocation procedures, and multiple assessment time points to further investigate flexibility adaptations in youth athletes.

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Conclusion

Both static stretching and passive stretching with assistance significantly improved flexibility in high school basketball players after six weeks of training. Passive stretching with assistance resulted in greater flexibility gains than static stretching, likely due to enhanced stretch tolerance and greater exposure to end-range joint positions. These findings support the inclusion of assisted stretching techniques in supervised athletic training programs while reinforcing the continued use of static stretching as a safe and effective method in school-based physical education.

Suggestions

Future studies should examine the long-term effects of assisted stretching on injury risk and athletic performance in adolescent populations. Additionally, research comparing different intensities and frequencies of assisted stretching may help optimize flexibility training protocols for school and youth sport settings.

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