

Literature Review of the Effects of Static Stretching and Dynamic Stretching on Jumping Performance in Volleyball Players

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Abstract: *Static stretching (SS) and dynamic stretching (DS) are widely used in sports training, and the effects of these two techniques on volleyball players' jumping performance and how to reasonably use them to improve jumping performance have been widely discussed in the academic community. This paper adopts the literature review and comparative analysis methods to investigate the effects of SS and DS on volleyball players' jumping performance. The study results showed that SS is beneficial in increasing the range of motion (ROW), enhancing muscle flexibility and reducing the risk of injury. At the same time, DS is beneficial in increasing muscle temperature and activation and enhancing the activation of the nervous system, which provides scientific and practical theoretical guidance for selecting stretching methods in strength and conditioning (S&C). Most current studies only focus on the short-term benefits of stretching on exercise performance, ignoring its long-term benefits. Meanwhile, the design of different stretching protocols in the literature varies in sample size, limiting the generalisability of the results. Future research directions include optimising the application of SS and DS in different sports, investigating the temporal effects of their physiological and performance impacts, and furthering more scientific and practical theoretical guidance in S&C practice.*

Keywords: *Static Stretching, Dynamic Stretching, Volleyball, Jumping Performance, Strength and Conditioning*

1. Introduction

Vertical jump is a standard tool used to assess the explosive power of volleyball players^[1]. Vertical jump height, i.e., the maximum vertical displacement of the athlete's centre of mass achieved during the flight phase of the jump, directly affects the athletic performance of volleyball players^[2]. In volleyball, the athlete's ability to have a high vertical jump is critical in completing techniques such as serving, spiking and blocking. Therefore, it is crucial to understand the effects of SS and DS on jumping performance. A reasonable selection of stretching methods can significantly enhance volleyball players' jumping performance in training and competition, achieving twice the result with half the effort. SS is to maintain a stretched position by actively contracting the muscle opposite to the muscle being stretched, while DS dynamic stretching is to achieve a challenging ROW by constantly moving the limb^[3]. However, the effects of SS and DS on jumping performance in volleyball players and how to appropriately use these two methods in conjunction with each other remain highly controversial. This literature review covered studies from 1996 to 2023, focusing on experimental studies, randomised controlled trials and retrospective studies. The literature search was conducted through PubMed, Google Scholar, Web of Science and CNKI databases using keywords such as 'static stretching', 'dynamic stretching', 'volleyball players', 'jumping performance' and 'strength and conditioning'. Inclusion criteria for the literature included studies on the effects of SS and DS on jumping performance in volleyball players and studies on other similar sports with a straightforward research design and a high degree of relevance to the research topic. Literature regarding the effects of SS and DS on volleyball players' jumping performance was collected and summarised. Subsequently, comparative analyses were conducted to compare the results of different studies, to find out the differences between SS and DS on the jumping performance of volleyball players, and to make recommendations for the rational use of SS and DS. Stretching is no longer a 'ritual'. However, it is more directed and effective, which is expected to optimise volleyball players' pre-game preparation and post-game recovery and improve their overall game performance. This study is structured as follows: first, in the literature review section, the existing relevant literature is reviewed and summarised, the effects of SS and DS on volleyball players' jumping

performance are discussed, and comparative and applied analyses are conducted. Then, in the conclusion section, the main findings and recommendations of this paper will be demonstrated, and future research directions will be proposed.

2. Systematic Review of the Literature

2.1. Static Stretching

The use of SS alone and performed correctly can enhance muscle extensibility and reduce the risk of injury. However, many studies have identified adverse effects of SS protocols on subsequent muscle performance [2]. The acute effects of SS on explosive strength remain controversial [26]. For example, Behm et al. showed that SS performed before an explosive jumping exercise may decrease jump height [4], and Yamaguchi et al. showed that concentric dynamic constant external resistance training (DCER) movements significantly reduced power output after SS was performed [5]. A study by Thompsen et al. found that hip, knee, and ankle extensors repeatedly after performing SS, 3 times, for 20 seconds each, the vertical jump height was significantly reduced [6]. This has raised questions among researchers about the effects of using SS before sporting events that require high power output [7].

SS exercises before exercise help to increase muscle length, enhance muscle flexibility and effectively reduce the incidence of muscle strains through greater freedom of movement, but SS may temporarily soften muscle strength and power, which may be due to neural and viscoelastic mechanisms [8]. However, Egan et al. found peak torque (PT) ($p = 0.161$) and mean power output (MP) ($p = 0.088$) from pre-SS to post-SS, which could indicate that SS did not cause stretch-related changes in PT and MP during maximal voluntary concentric isometric leg extension in trained athletes [10]. Meanwhile, Unick et al. reported that there was no significant decrease in jumping performance when SS was performed 4 minutes before testing vertical jump height, so it was surmised that vertical jump performance was less affected by SS [11].

Whilst SS is unlikely to reduce the incidence of all-cause injuries, there is evidence that SS can reduce tendon injuries, particularly in explosive sports [9]. Despite the role of SS in injury prevention, SS can have an acute adverse effect on pre-exercise maximal muscle strength and muscle explosiveness regardless of the age, gender or training status of the subject and needs to be considered with caution if SS is applied solely during warm-up [8].

In summary, athletes performing SS only before volleyball jumping manoeuvres may reduce the risk of muscle strains to some extent. Still, they may have a temporary adverse effect on muscle strength, thus reducing performance. Therefore, skill level and familiarity with the performance test may be important mediators of the acute impact of SS on subsequent athletic performance [12]. The duration of stretching [27], the manner of stretching [28], or whether it is combined with dynamic activity [29] are key factors that significantly influence acute strength changes. As various factors can influence stretching, special attention needs to be paid to some differences that may vary by level of exercise or gender [30].

2.2. Dynamic Stretching

DS alone and performed correctly can provide athletes with increased body temperature, enhanced neural activity, and improved muscle elasticity, which improves muscle performance in preparation for explosive movements. However, if not performed correctly, it may cause muscle damage. Significant agility and horizontal jumping performance improvements were observed after performing DS [13]. Similarly, Thompsen et al. mentioned a significant increase in vertical jump height after performing DS in a group of female athletes from different sports [6]. During concentric resistance contraction, performing DS positively improved power output, sprint running time and vertical jump performance [14]. DS and various stimulus modifications can induce subsequent improvements in athletic performance [15]. Performing DS results in a rapid increase in muscle temperature, which improves muscle performance and increases leg extension strength [16]. However, it should be noted that if the DS is performed at too high an intensity, it results in overworked muscles, inhibitory effects on the nervous system, and excessive energy expenditure, which may be compromised during explosive movements [17].

In conclusion, the dynamic nature of DS is more effective in helping the muscle-tendon units to activate more rapidly in preparation for explosive jumping movements. However, performing incorrect or too intense DS may affect the output of explosive power and may even lead to muscle strains. Nevertheless, performing DS with correct movements to increase muscle flexibility, muscle temperature,

and neural activation can enhance muscle power output and athletic performance; therefore, performing DS is a favourable option for volleyball players' jumping performance.

2.3. Comparison and Analysis

The current literature study can conclude that there are advantages and disadvantages to using SS or DS alone. Performing DS before exercise may be a safer and more effective alternative to SS and should be implemented into a warm-up stretching programme^[18]. Hough et al. also concluded that incorporating DS into a warm-up session may provide a viable alternative to SS^[19]. Chaouachi et al. demonstrated that performing DS may be more effective than SS in increasing jump height and noted that the decrease in muscle performance after performing SS is due to mechanical and neurological factors, but that if DS is used in combination with SS, it will reduce the deficiencies associated with SS alone, such as acute strength and power decreases, neuromuscular inhibition, and muscle viscoelasticity effects^[20].

Many studies have concluded that the effects on the jumping performance of volleyball players after performing DS are superior to those of SS. However, the value of SS in overall athletic training still cannot be ignored. Although DS appears to improve jumping performance in volleyball players rapidly, the role of SS in long-term mobility and injury prevention should also be considered, so combining SS and DS in warm-up scheduling may provide a balanced approach to improving overall athletic performance and reducing the risk of injury, and perhaps in this way compensate for each other's potentially detrimental effects when used individually, with the two being mutually reinforcing and reinforcing.

The broad applicability of this conclusion needs to be validated by more research under different conditions, such as different sports, different ages and genders, different training levels, different pull-up durations and frequencies, different measures of jumping performance, and different sports environments. More in-depth research is needed to determine the effects of different stretching programmes on the performance of trained athletes, primarily based on published recommendations, which would guide the S&C coaches in selecting a more individually tailored technique for the athlete during the stretching session^[2].

3. Applications

3.1. Relaxation phase

Although the relaxation phase of SS may temporarily reduce strength output, the role of SS in improving flexibility and reducing the risk of injury should be considered. Chaabene et al. demonstrated that SS of less than 60 seconds had a negligible effect on strength and explosive performance^[22]. Magnusson et al. demonstrated that performing SS with five repetitions of 90 seconds each reduced muscle resistance, passive stiffness, peak torque and stress relaxation^[24]. Kubo et al. also illustrated that changes in the viscoelasticity of the muscle-tendon unit are more dependent on the duration of the stretch^[25]. Therefore, it is recommended that S&C coaches include SS in their warm-up as it has a positive impact on improving flexibility and injury prevention. However, the application of SS should be considered with caution in competitive athletes due to slight differences in performance that may affect an athlete's success in competition. Post-training or recovery days are ideal times to perform SS, focusing on the major muscle groups used in volleyball, such as hamstrings, quads, calves and shoulders. The potential mechanism by which regular SS can improve strength and activity performance is that if a muscle group is stretched 30 to 60 times per day for several months, it induces muscle hypertrophy and improves strength production and athletic performance in all activities^[23].

3.2. Warm-up phase

Stretching during the warm-up phase and performing DS significantly improved athletic performance, and the effects produced by using SS as a warm-up activity alone need to be demonstrated more^[13]. As DS improves muscle temperature, flexibility, explosiveness, agility and jumping performance, DS should be the mainstay of the pre-training and pre-competition warm-ups, with SS as an adjunct and the addition of dynamic activities mimicking volleyball, such as jumping, lateral movement and sprinting, to prepare the body for the demands of a particular game. As Behm et al. showed, optimal warm-ups should include sub-maximal intensity aerobic exercise, substantial DS, and dynamic activities characteristic of the sport^[21].

4. Conclusions and Recommendations

There is current controversy regarding the effectiveness of SS and DS in enhancing jumping performance, with some studies suggesting that performing DS has a more positive impact on enhancing jumping performance than SS, while others have noted that performing SS may have a negative impact on jumping performance. However, other studies have noted that performing SS has no significant effect on vertical jumping performance. Whilst DS appears to be more effective in improving jumping performance in volleyball players, the role of SS in long-term mobility and injury prevention should also be considered, as the value of SS in overall athletic training remains until movements requiring explosive jumping are performed.

In conclusion, although SS and DS play an important role in sport preparation, and performing SS can be helpful in increasing ROW, enhancing muscle flexibility and reducing the risk of injury, whereas performing DS is beneficial in increasing muscle activation and temperature and activating nerves, it needs to be applied appropriately according to the specifics of the sport and the individual athlete. In addition, most studies have focused mainly on the immediate short-term effects of stretching on sports performance and less on its long-term effects. This limitation may lead to overlooking the potential benefits of stretching as an integral part of a training routine rather than just part of the warm-up prior to training and competition.

S&C coaches should assess the basic strength and conditioning of each player, including body composition, cardiorespiratory endurance, muscular strength, muscular endurance, flexibility, agility, balance, coordination and speed^[31]. The stretching programme is also adapted to meet specific limitations or needs based on individual differences in players. Athletes should also be aware of their current training and playing demands, physical mobility level, flexibility level and injury history to rationalise their stretching arrangements.

This study recommends that volleyball players use a combination of SS and DS to optimise performance prior to training and competition. The specific protocol is as follows: before training and competition, perform SS for a short period of time to ensure adequate muscle stretching and warm-ups, and then perform DS for 5-10 minutes or longer, including anterior-posterior and lateral leg swings, high leg raises, and lunges to increase muscle temperature and neural activation, thereby enhancing explosive power and agility. Finally, warm-ups incorporating volleyball sports characteristics such as simulated dunking, blocking, and quick movement help the body adapt more quickly to the upcoming practice or match. After a practice or match, perform static stretches such as hamstring, quad and shoulder stretches lasting greater than 60 or even greater than 90 seconds each and repeated five or more times to increase muscle flexibility and reduce muscle tension, thereby promoting recovery and preventing injury. The judicious use of both types of stretching can maximise athletic performance and reduce injury risk.

Finally, differences in the design of stretching protocols (e.g., duration, frequency, etc.) across studies and the small sample sizes of many studies limit the generalisability of the findings. Future research should address the limitations of the current methodology and explore the long-term effects of both stretching modalities on athletic performance and injury rates. The transition from SS to DS lacks consistent evidence for performance improvement and injury reduction, and more in-depth studies are needed to validate the benefits. This nuanced understanding will better guide S&C training and align it with the athletic needs of volleyball players.

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