SPORT - Science & Practice, Vol. 14, №1-2, 2024, pp. 45-52.

Scientific Review **CC BY**

THE EFFECT OF ELASTIC BAND APPLICATION IN TRAINING PROGRAM OF BASKETBALL PLAYERS [1]

UDC: 796.015.6
572.51:796.323.2
DOI: 10.5937/snp14-1-2-54937

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Abstract: The aim of this review paper is to analyze studies that have examined the impact of using elastic bands in basketball players' training processes, as well as to provide a practical training program proposal incorporating elastic bands. The sample consisted of studies from electronic scientific databases, with a total of eight studies meeting the required inclusion criteria. The results, presented in tabular form, include descriptive statistics (anthropometric characteristics, sex and age), the duration and details of each training program implemented, and tests used to assess the effects of elastic band application in the selected studies. All analyzed studies confirmed a positive effect of elastic bands on at least one motor ability of basketball players, aligning with the hypothesized outcomes of the respective authors. Consequently, it can be concluded that elastic bands should be integrated into training programs all year round. Their use can be adjusted depending on the phase of the competitive season: from developing maximum force in conjunction with weights during the preseason, through individual application for enhancing maximal movement and running speed, to improving and maintaining specific abilities such as explosive power in jumps and rapid direction changes during the competitive period. Given their broad application, it is recommended that coaches incorporate elastic bands into training programs, ideally alongside weights or independently, in three weekly training sessions. Considering their extensive impact, their application should be tailored to the specific needs of individual athletes.

Keywords: *elastic band, training, basketball*

INTRODUCTION

In most sports, achieving top results is highly dependent on possessing high levels of physical fitness among competitors. Since the early days of sports, coaches have sought to understand and better explain each component of physical fitness, as well as to find the most efficient and effective ways to develop them. Basketball is a dynamic sport characterized by advanced movement patterns, primarily jumps and sprints. The ability to perform these movements efficiently and with high quality depends on possessing well-developed physical abilities, among which muscle strength and power are considered the most important (Schelling & Torres-Ronda, 2016). Various training methods can be used to improve these abilities, with resistance training being the most extensively researched (San-

[1] Paper received: November 22, 2024; edited: December 19, 2024; accepted for publication: January 8, 2025
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tos & Janeira, 2012; Westcott, 2012; Naclerio et al., 2013). Research consistently demonstrates the positive effects of different types of resistance training in increasing muscular strength and power, both in athletes and the general population.

With advancements in sports science, there is a constant influx of new findings regarding the influence of different training tools. Kompf and Arandjelović (2016, 2017) explored neural muscle activation at specific joint angles during full-body resistance exercises (such as squats, bench presses, and deadlifts) and concluded that using only constant resistance (weights) (CRT) does not maximize muscle activation. As a solution to this problem, machines that adjust load intensity throughout different phases of an exercise were developed. However, these machines are often very expensive, limiting their wider application and prompting researchers and coaches to seek more affordable alternatives to optimize training for both athletes and coaches.

One such alternative is variable resistance training (VRT), which involves the addition of elastic bands to traditional weight training. This method is designed to minimize reduced velocity at certain points in a movement, thereby increasing neural activation and enhancing strength and power development. Studies have shown that improvements in these abilities tend to be greater with VRT compared to traditional constant resistance training (CRT), provided certain principles are followed (Wallace et al., 2006; Anderson et al., 2008; Joy et al., 2016; Labat & Hey, 2017).

In addition to being used alongside free weights, elastic bands can also be applied independently in various training methods. A study by Vinothkumar and Kumaran (2018) on college basketball players in India demonstrated that leg strength and power can be improved through elastic band exercises alone, without the use of free weights. Similarly, Kamandulis et al. (2018) found that incorporating elastic bands into high-velocity exercises can enhance leg movement speed, sprint performance, neural activation speed, and lower-body strength. Despite the many reported benefits of elastic bands, some researchers have identified limitations in their application, particularly in cases where no additional benefits are observed. When elastic bands are used in combination with free weights, their intensity is typically measured as a percentage of one-repetition maximum (1RM) M (Joy et al., 2016). To maximize training effects and adaptations, the recommended band resistance should be at least ≥ 20% 1RM, with the most significant effects observed at ≥ 30-40% 1RM (Joy et al., 2016; Shi et al., 2023).

Overall, the use of elastic bands in modern training programs has proven to be beneficial for athletes. However, current literature contains conflicting findings, as well as variations in band application methods. Given that basketball performance is highly dependent on players' physical abilities—and considering the potential of elastic band training to enhance these abilities—there is a lack of precise guidelines regarding their optimal use. Therefore, a review paper on the effects of elastic bands in basketball training is necessary to provide clear recommendations for their implementation.

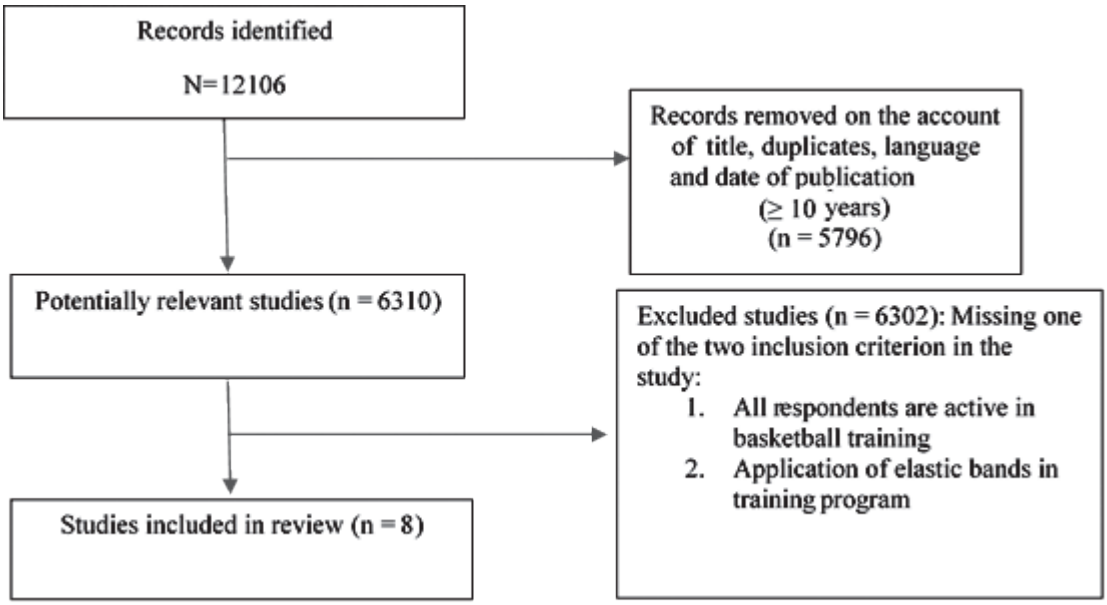
With this in mind, the main goal of this study is to compile and analyze relevant research and to identify the most effective methods of elastic band application in basketball training programs. The hypothesis is that incorporating elastic bands alongside free weights provides the most effective training approach for developing and maintaining basketball players' physical abilities.

METHOD

The criteria for including studies primarily related to the language and publication date of the papers. All studies written in English and published from 2014 onward were considered for further review. The literature search was conducted using PubMed, Google Scholar, and SCIndeks, as well as the library of the Faculty of Sport and Physical Education. Furthermore, the analysis included all studies that met the following criteria: (1) the application of elastic bands in training programs aimed at developing physical abilities, (2) all participants were actively engaged in basketball. All study designs were included, except for review papers. For the purpose of this study, statistical values were extracted from the analyzed studies, as all of them examined the effects of elastic bands using an experimental method. A total of eight studies met the specified inclusion criteria.

The literature collection process began by reviewing the titles and abstracts of the studies after entering the keywords (*ELASTIC BAND, TRAINING, BASKETBALL*) into the aforementioned databases. Only papers that met the inclusion criteria were reviewed in full text (Picture 1).

Picture 1. *Flow chart diagram on research of relevant studies*



RESULTS

Through literature research, a total of 12106 studies was found. After a brief review, 5796 studies were excluded, while 6310 were left for further analysis. According to the inclusion criterion for this review paper, a total of 8 studies was accumulated, which were published around the world, in English language, from 2014 onward, where all respondents are young, active basketball players and where elastic bands represent the main point of the research. Table 1 shows descriptive data regarding the respondents (age and anthropometric measurements), as well as the duration of the program and the way of use of the elastic bands in training programs for each individual research.

Table 1. *Respondents' descriptive data and duration of training program for each individual study (E- experimental group; C- control group)*

No	Study	Respondents	Age	Height and weight	Program exper./contr. group
1.	Joy et al., 2016	14 (E = 7, K = 7)	College	191.4 ± 12.5cm 91.8 ± 13.2kg	5 weeks 4x bands+weights/ weights
2.	Vinothkumar & Kumaran, 2018	20 (E = 10, K = 10)	18-23	/	6 weeks 3x bands/no training
3.	Kamandulis et al., 2020	18 (E = 10, K = 8)	21.5 ± 1.7	192.5 ± 5.4cm 83.5 ± 8.9kg	5 weeks 3x bands/no training
4.	Shi et al., 2022	20 (E = 11, K = 9)	20.8 ± 1.4	186.3 ± 7cm 82.8 ± 12.8kg	8 weeks 2x bands+weights/ bands
5.	Nugroho et al., 2023	20 (E = 10, K = 10)	/	/	bands/weights

6.	Chun & Jiechun, 2023	20 (E = 10, K = 10)	16.08 ± 0.705 K 16.63 ± 1.129 E	189.26 ± 3.515cm C 82.63 ± 12.591kg C 188.05 ± 6.820cm E 83.66 ± 9.963kg E	6 weeks 3x bands+weights/ weights
7.	Shi et al., 2023	13, no groups	20.05 ± 0,9	188.5 ± 8.5cm 82.8 ± 12.9kg	9 workouts (5 practice i 4 experimental) bands+weights/ weights
8.	Tyagi et al., 2024	30 (E = 15, K = 15)	24.71 ± 8.3 K 24.00 ± 3.66 E	181.22 ± 4.59cm C 80.07 ± 3.19kg C 178.59 ± 3.69cm E 78.87 ± 4.62kg E	8 weeks 3x bands/weights

More detailed information about the specific application of elastic bands in training programs, as well as the effects and impact of the programs on motor abilities and the values of tests in each individual study can be found in Table 2.

Table 2. *The way of elastic band application and the values of changes in control tests before and after the conducted training in the experimental (E) and control (C) groups for each study*

No.	Study	Way of band application	Research results (pretest and post-test values)
1.	Joy et al., 2016	Band applied to 1 of 4 weekly workouts, 30% 1RM on squat and bench press exercises	• 26.63% growth in squat weight in E as opp. to 20.03% in C group • 7.72 % growth in bench press weight in E as opp. to 3.30 in C group • 6.57% growth in maximal power in E as opp. to reduction -5.35% in C group • 20.54% growth in rate of power development (RPD) in E as opp. to reduction -12.39% in C group • 6.33% growth in vertical jump in E as opp. to 4.13 in C group • No improvements in sprint ability on 40 yards in either group
2.	Vinothkumar & Kumaran, 2018	Elastic band application as the main means of a workout 3x a week. Group C not doing anything during the program.	• Leg strength in E group increased from 71.7 to 75.8 (statistically significant difference in strength $p < 0.05$) on group average, while C group had minimal changes- from 71.1 to 71.4
3.	Kamandulis et al., 2020	Elastic band application in high velocity movements (knee flexion through hamstring activation) of lower extremities 3x a week. C group not doing anything during the program.	• Speed of knee flexion increased for 25.7% in E group, as opposed to 2.6% in C group • Strength of neural signal (EMG) grew in muscles “Biceps Femoris” and “Rectus Femoris”, while the changes in “Sartorius” were not seen in E group • Duration of neural activation was shortened in said muscles during movements they perform (knee flexion and extension) • Increase in muscle strength in lower speed movements (21.5%) as well as high speed movements (25.8%) • 30-meter sprinting increased by 1.6% from crouch start and by 2.1% from flying start

4.	Shi et al., 2022	Elastic band application as an addition to squat training 2x a week	• In E group for 1RM squat 36.5% increase, in C group 32.3% increase • In E group "Counter-movement jump" 12.9% increase, in C group 5.6% increase • In E group "Squat-jump" 21.4% increase, in C group 12.9% increase • In E group "Standing broad jump" 2.9% increase, in C group 2% increase • No increase in 10m and 20m sprint performance in either group
5.	Nugroho et al., 2023	Elastic band application as the main means of each workout	• In players who had higher power values before the program in E group, leg strength increased from 45.6 to 48.8 • In players who had lower power values before the program in E group, leg strength increased from 37.0 to 38.6 • In players who had higher power values before the program in C group, leg strength increased from 45.6 to 47.0 • In players who had lower power values before the program in C group, leg strength increased from 37.4 to 39.2 • Better impact of band training for players with higher levels of power and better impact of free weights training on players with lower levels of power
6.	Chun & Jiechun, 2023	Elastic band application as an addition to free weight training 3x a week	• Bigger growth in E group in push up count (37.03 PRE 55.15 POST; than group C (38.60 PRE 53.37 POST) • Bigger growth in E group in sit-up count (47.10 PRE 68.69 POST), than group C (46.42 PRE 67.14 POST) • Bigger growth in E group in triple jump from standstill (7.86m PRE 8.23m POST) than group C (7.94m PRE 8.13m POST) • Bigger growth in E group in vertical jump (64.32cm PRE 71.68cm POST) than group C (62.84cm PRE 66.42cm POST) • Agility and running tests on 1500m: lower results on POSTTEST than on PRETEST values for both groups • Also, E group has better POSTTEST values for specific basketball tests on the court than group C
7	Shi et al., 2023	Testing acute effects of band application on vertical jump, power and rate of force development in leg muscles. 4 different squat variations: free weights only, weights + 20% 1RM band, weights + 30% 1RM band, weights + 40% 1RM band	• Squats with weights and weights + 20% band both had value increase but without statistical significance in acute effects of vertical jump, peak power output and rate of force development, while weights + 30% and 40% bands had significant differences: • In vertical jump, the 30% band shows a statistically significant increase after 3min and 6min, while the 40% band shows it in all four time measurements (30s, 3min, 6min, 9min). In peak power, only 30% band after 3min and 6min, and in rate of force development, both 30% and 40% bands show a significant increase after 3min, and the 40% one shows it also 6min after squatting.
8	Tyagi et al., 2024	Elastic band application as the main means of each workout 3x a week	• E group has a higher percentage growth in POSTTEST values in all conducted tests than group C • 9.13% in opp. to 8.35% in ball velocity after a pass • 24.96% in opp. to 24.83% in lower extremity power • 8.24% in opp. to 8.13% in upper extremity speed • 22.25% in opp. to 22.12% in basketball shooting drill • 30.29% in opp. to 30.19% in disc tapping

DISCUSSION

The results indicate that all studies confirmed the effectiveness of elastic bands in improving basketball players' performance. However, what differentiates these studies and categorizes them into distinct groups is the method of band application and its impact on both physical and sport-specific abilities in basketball. Studies in which control groups were inactive have naturally shown better performance in experimental groups. However, what draws attention is the comparison of this training method with others. All studies that compared the results of two groups used a combination of weight training and resistance bands in the experimental group, while the control groups trained with weights only (Joy et al., 2016; Shi et al., 2022; Chun & Jiechun, 2023; Tyagi et al., 2024). To better understand why studies that combined weights and bands showed superior results, it is necessary to examine which physical attributes were examined.

Muscle strength refers to the muscle's ability to generate force under isometric conditions. Research measuring force production indicates varying responses to different training methods (Vinothkumar & Kumaran, 2018; Nugroho et al., 2023). The findings of Vinothkumar and Kumaran support the effectiveness of elastic band training for increasing strength, whereas Nugroho et al. came to slightly different conclusions. Their study suggests that participants with higher pretest power levels benefited more from band training, while those with lower power levels responded better to free-weight training. To determine whether band training is truly the optimal choice for strength development in athletes, further research with larger sample sizes is needed.

Power is defined as the amount of work performed per unit of time. Two studies analyzing power compared an experimental group (using a combination of weights and bands) with a control group (using only free weights) (Joy et al., 2016; Chun & Jiechun, 2023). Both studies reported greater power output in the combined training group. Additionally, Tyagi et al. (2024) compared training with only bands vs. only free weights and also found that elastic bands were superior in developing power. The difference in the results between experimental and control groups can be attributed to the unique properties of elastic bands. At the starting position of an exercise, the band is at its shortest length and does not provide significant additional resistance. However, as movement progresses, the band lengthens, increasing the resistance at the end range of motion. In contrast, free weights provide constant external resistance throughout the movement. This variable resistance characteristic of bands stimulates greater neuromuscular activation at longer muscle lengths, promoting adaptation throughout the entire range of motion. The higher neural stimulation observed in elastic band training contributes to better adaptation among participants (Kamandulis et al., 2020).

The rate of force development (RFD) increased with band training, which authors also attribute to enhanced neural stimulation at end-range movement amplitudes, leading to more effective adaptation (Kamandulis et al., 2020; Shi et al., 2023). Shi et al. identified that bands with 40% of 1RM resistance were the most effective for improving this attribute.

Besides the rate of force development, power development rate is even more crucial for athletes, particularly basketball players. Studies show that power development rate improves more when training combines bands and weights compared to training only with free weights (Joy et al., 2016). A vertical jump test is often used as a practical assessment of power development, as it requires generating high force in a short time. Due to the higher neural stimulation provided by bands, athletes can generate greater force within the same time frame, leading to improved post-test jump performance compared to initial measurements (Joy et al., 2016; Shi et al., 2022; Chun & Jiechun, 2023; Shi et al., 2023).

Although 1RM (one-rep max) is not a primary determinant of basketball performance, it has consistently shown higher values when training with a combination of bands and weights compared to free weights alone (Joy et al., 2016; Shi et al., 2022; Shi et al., 2023).

In addition to physical attributes, some studies measured sport-specific skills directly related to basketball performance. These skills included: successful pass distance, fast-break duration, ball speed after passing, shot execution speed, etc. All evaluated skills showed significant improvements in post-tests (Chun & Jiechun, 2023; Tyagi et al., 2024). As previously stated, elastic band training enhances neural stimulation, leading to better adaptation to training demands. Since basketball skills are directly influenced by physical abilities, it is logical that improvements in strength and power translate to better sport-specific performance.

Most studies that observed performance improvements in repeated testing reported using three weekly training sessions with elastic bands (Joy et al., 2016; Vinothkumar & Kumaran, 2018; Kamandulis et al., 2020; Chun &

Jiechun, 2023; Tyagi et al., 2024). The optimal band resistance for this frequency (three weekly sessions) appears to be 30% of 1RM, as it provides an adequate training stimulus and leads to measurable improvements (Joy et al., 2016; Shi et al., 2023).

CONCLUSION

A training program that incorporates elastic bands, when applied correctly, will lead to better adaptation in athletes. The effectiveness of elastic bands is based on their elastic properties, which allow for variable resistance at different muscle lengths. The force generated within a muscle depends directly on its length, with the highest force output occurring at its optimal length. The use of elastic bands provides additional muscle stimulation at the end range of motion, leading to greater neural activation and, consequently, improved adaptation. One of the greatest advantages of elastic bands is their impact on sport-specific abilities, which are crucial for basketball performance. This alone suggests that elastic bands should be integrated as a key component of training programs throughout the entire season. At the beginning of the preparatory period, when the focus is on developing maximal strength and injury prevention, bands with 30% of 1RM resistance should be used in conjunction with free weights. This training should be performed three times per week, following the same volume and intensity as traditional weight training to achieve maximum results. As the competitive season approaches, the application of elastic bands can be modified to target sprinting performance and movement speed. During this phase, bands can be used three times per week, with each session beginning with high-speed movement exercises using bands after a proper warm-up. This addition enhances the development of basketball-specific abilities, complementing the rest of the training regime. During the in-season period, when competitions are ongoing, elastic bands can serve as a maintenance tool for preserving specific basketball abilities, such as quick directional changes and vertical jumps.

The implementation of elastic bands in the physical preparation of basketball players has been proven to yield positive effects. Using bands exclusively can significantly reduce the costs of physical preparation for both individual athletes and clubs. Based on the findings of these studies, basketball coaches and strength & conditioning trainers should incorporate elastic bands into their athletes' physical preparation throughout the entire season—either in combination with free weights or even as a substitute for them.

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